

Results of Research in 1949

by the

Agricultural Experiment Station

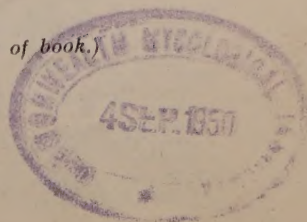
of the

University of Kentucky



62nd Annual Report
of the Director

(See the "Index to Subject Headings" at back of book.)



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AGRONOMY

Kinney, E. J., Head
Austin, Calvin M., Assistant Chemist
Bortner, C. E., Associate Agronomist
Buckner, Robert C., Assistant Agronomist
Diachun, Stephen, Associate Plant Pathologist
Fergus, E. N., Agronomist, Pasture and Forage Crop Investigations
Freeman, J. F., Associate Agronomist
Griffith, R. B., Assistant in Tobacco Research (Resigned Feb. 15, 1949)
Harrison, John S., Assistant Agronomist
Henson, Lawrence, Associate Agronomist in Forage Crop Investigations
Houston, F. G., Assistant Chemist
Johnson, E. M., Plant Pathologist
Josephson, L. M., Associate Agronomist
Karraker, P. E., Agronomist in Soil Technology
Kaufman, Ruth C., Assistant Analyst (Resigned March 31, 1949)
Kelley, J. B., Agricultural Engineer
Link, Leo A., Assistant in Agronomy
Miller, Harold F., Assistant Agronomist
Ockerman, Louis, Chemist
Reid, David A., Associate Agronomist
Schember, Victor E., Assistant Agronomist (Resigned Aug. 24, 1949)
Shedd, O. M., Chemist
Skinner, Robert E., Agricultural Engineer
Spencer, Jack Taif, Associate Agronomist (Resigned Dec. 13, 1949)
Thaxton, Robert M., Assistant Agronomist
Todd, Jack R., Assistant Agronomist
Valleau, W. D., Plant Pathologist
Weeks, Martin E., Agronomist
Wood, L. K., Spectrographer and Research Chemist

ANIMAL INDUSTRY GROUP

Garrigus, W. P., Chairman
Barber, Harold, Head Herdsman
Barnhart, Charles E., Assistant in Animal Husbandry
Blue, James L., Jr., Field Agent in Cream Grading (Resigned June 30, 1949)
Buckner, G. D., In charge Animal Nutrition Section
Culton, Thomas Grover, Assistant in Poultry
Curtisinger, Thomas A., Field Agent in Cream Grading
Dozier, Emmitt, Jr., Superintendent of Creamery
Duff, Mike, Assistant Field Agent in Poultry Improvement (Resigned Dec. 13, 1949)
Dutt, Ray H., Assistant in Animal Husbandry
Elliott, Ralph F., Assistant in Dairy Husbandry
Forbes, Richard M., Associate in Animal Husbandry (Resigned Sept. 14, 1949)

Animal Industry Group—Continued

Freeman, Theodore R., Associate in Dairy Manufacturing
Henry, Amanda H., Assistant in Animal Nutrition
Insko, W. M., Jr., In charge Poultry Husbandry
Johnson, Forrest D., Assistant in Animal Husbandry (Resigned June 30, 1949)
King, Wallace L., Field Agent in Cream Grading
MacLaury, Donald W., Assistant in Poultry Husbandry
Matthews, J. W., Field Agent in Poultry Improvement
Morrison, H. B., Jr., Associate in Dairy Husbandry
Olds, Durward, Assistant in Dairying
Seath, Dwight M., In charge Dairy Section
Steele, D. G., In charge Genetics Section
Wightman, E. T., Assistant in Poultry Husbandry
Wilford, E. J., Assistant in Animal Husbandry, In charge Meats Laboratory

ANIMAL PATHOLOGY

Hull, F. E., Head
Brown, Ross, Assistant Veterinarian
Bruner, D. W., Bacteriologist (Resigned Sept. 30, 1949)
Dimock, W. W., Veterinarian
Doll, E. R., Veterinarian
Hansen, Merle F., Associate Parasitologist
Hopson, Alice Kinkaid, Assistant Bacteriologist
Kelley, George W., Assistant Parasitologist
Mandia, James William, Assistant Bacteriologist
McCollum, William H., Assistant Bacteriologist
Moran, A. Barbara, Assistant Bacteriologist
Smith, Marianne F., Assistant Veterinarian
Todd, Arlie C., Parasitologist
Wallace, Elizabeth, Assistant Bacteriologist
Williams, Mary Ann, Assistant Parasitologist
Wyant, Zae, Technician

CREAMERY LICENSE SECTION

Foster, J. D., Inspector in charge
Brown, J. B., Inspector
Lawrence, Chester, Assistant Inspector

ENTOMOLOGY AND BOTANY

Price, W. A., Head
Anderson, Mary L., Seed Analyst
Baugh, Lucy G., Seed Analyst
Cundiff, Charlotte B., Seed Analyst (Resigned Aug. 31, 1949)
Deen, Encil, Seed Inspector
Harned, Jessie H., Seed Analyst
Jewett, H. H., Associate Entomologist
McDaniel, Alice, Seed Analyst
Morton, Margaret, Seed Analyst
Rhoades, W. C., Assistant Entomologist (Resigned April 21, 1949)
Ritcher, P. O., Entomologist (Resigned July 1, 1949)
Rodriguez, Juan G., Assistant Entomologist
Tilson, Howard G., Nursery Inspector
Todd, Anne, Seed Analyst
Vaughn, E. C., Field Agent in Seed Improvement
Wiles, Mabel, Seed Analyst

FARM ECONOMICS

Nicholls, W. D., Head
Back, William B., Assistant in Farm Management
Bishop, Charles E., Assistant in Farm Management
Bondurant, J. H., Economist in Farm Economics
Byers, G. B., Associate Economist
Criswell, James E., Assistant in Farm Management

Johnson, Glenn L., Associate Economist
McComas, Paul S., Associate Economist
Nesius, E. J., Assistant Economist
Vice, Keith R., Assistant in Farm Management

FEED AND FERTILIZER

Poundstone, Bruce, Head
Allen, H. R., Chief Chemist
Anderson, Josiah E., Assistant Inspector
Blanchet, Rose Marie, Assistant Chemist
Gault, Lelah, Assistant Chemist
Howard, N. J., Inspector
Hulette, Neville, Feed Inspector
Mathews, Robert, Chief Inspector, Assistant Administrator
Midkiff, V. C., Assistant Chemist
Shrader, J. A., Microscopist
Swift, Elizabeth Ann, Assistant Chemist

HOME ECONOMICS

Erikson, Statie, Head
Boyden, Ruth, Assistant
Mitts, Mary Louis, Assistant

HORTICULTURE

Olney, A. J., Head
Armstrong, W. D., Horticulturist
Chaplin, Carl E., Assistant Horticulturist
Davenport, O. M., In charge Forestry Section
Emmert, E. M., Assistant Horticulturist
Klinker, John Edward, Assistant Horticulturist
Waltman, C. S., Associate Horticulturist

MARKETS AND RURAL FINANCE

Brown, A. J., Head
Card, Dana G., Associate Economist in Agricultural Prices
Clark, C. M., Associate Economist in Agricultural Marketing
Gilbert, Edgar A., Assistant in Marketing
Gooch, Ernest D., Jr., Assistant Economist
Grayson, Ulysses G., Assistant in Marketing
Hornbeck, B. L., Forester
Phillips, C. D., Associate Economist in Agricultural Marketing
Price, H. B., Economist
Roberts, John B., Associate Economist in Agricultural Marketing
Rudd, Robert W., Assistant Economist in Agricultural Marketing

PUBLIC SERVICE LABORATORIES

Brown, L. A., Head
Fallis, R. W., Assistant Bacteriologist
McGuire, H. S., Jr., Assistant Bacteriologist
Meador, A. L., Assistant Chemist
Terry, Geo. S., Bacteriologist

BROWN SUBSTATION

(Quicksand, Ky.)

Jones, R. W., Superintendent
Wiggin, G. H., Forester (Resigned Nov. 30, 1949)

RURAL SOCIOLOGY

Beers, Howard W., Head
Bauder, Ward W., Assistant Rural Sociologist
Brown, James S., Assistant in Rural Sociology

WESTERN KY. SUBSTATION

(Princeton, Ky.)

Lowry, S. J., Superintendent
Caldwell, L. M., Assistant Superintendent

LETTER OF TRANSMITTAL

*To His Excellency, Hon. Earle C. Clements,
Governor of Kentucky:*

Sir: In accordance with an act of Congress, approved March 2, 1887, entitled, "An act to establish Agricultural Experiment Stations, in connection with the Agricultural Colleges established in the several states under the provisions of an act approved July 2, 1862, and under the acts supplementary thereto," and of the act of the Legislature of the State of Kentucky, approved February 20, 1888, entitled, "An act to accept the provisions of an act passed by the Congress of the United States, approved March 2, 1887, for the establishment and maintenance of Agricultural Experiment Stations in connection with Agricultural Colleges established by the several states and territories under the act of Congress approved July 2, 1862," I herewith submit the sixty-second annual report of the Kentucky Agricultural Experiment Station.

Very respectfully,

THOMAS P. COOPER, Director.

RESULTS OF RESEARCH IN 1949

by the

KENTUCKY AGRICULTURAL EXPERIMENT STATION

(See "Index to Subject Headings," Pages 89 to 92)

Breeding tobacco for resistance to wildfire.—Up to 1949, breeding for wildfire resistance in burley tobacco had consisted in successive backcrosses of good type burley plants resistant to other diseases on wildfire-resistant plants containing the dominant resistance factor from *Nicotiana longiflora*. In 1949, after fairly thorough elimination of wildfire-susceptible plants from the F_2 of the fourth backcross in the plant bed, the remaining resistant plants were set in the field, inoculated with wildfire for further selection, and allowed to set seed from self pollination. A test of the progeny of over 600 plants showed that several were homozygous for wildfire resistance. It is not known whether crossing over has taken place between the longiflora chromosome and a tobacco chromosome; but a cytological study of TL106, a stable wildfire-resistant variety developed by the United States Department of Agriculture, showed it to be a 50-chromosome variety, presumably 24T+1L. Homozygous dark fire-cured hybrids have also been developed by backcrossing dark fired tobacco on wildfire-resistant burley.

New burley tobacco varieties.—Three new disease-resistant varieties of burley tobacco have been named Ky 26, Ky 35, and Ky 57. Ky 26 is a stand-up variety of high quality and good yield that is somewhat more resistant to black root rot than Ky 16. It has been grown the past few years under the designations BB 13-46. Ky 35 has been tested by many farmers under the designation F17A-46. It is resistant to fusarium wilt and mosaic (NN), and moderately resistant to black root rot. It has nearly completely replaced Ky 33 and Ky 34 in fusarium wilt areas. The yield is about equal to Ky 16, quality is fair, but the variety is very susceptible to injury by the veinbanding virus from potatoes. It causes, in place of the usually mild veinbanding symptoms, chlorosis followed by necrosis of small spots in the leaf that gradually coalesce to destroy large areas. The variety is also very sensitive to injury by corn pollen. In spite of these objections it is now commonly grown. Ky 57 is highly resistant to black root rot and is resistant to mosaic (NN). It appears to be slightly higher yielding than Ky 56 and seems to have better quality.

Resistance to etch and veinbanding viruses.—A wild species of tobacco received from Dr. F. O. Holmes as *Nicotiana tomentosiformis* proved, as he claimed, to be resistant to the etch virus and also appeared to be a symptomless carrier of the veinbanding virus. In view of the fact that the tobacco aphid is now well established in the United States, a source of resistance to these aphid-transmitted viruses may prove valuable. *N. tomentosiformis* also has the same type of resistance

to the mosaic virus that is found in the resistant variety Ambalema. This suggests that Ambalema, and related mosaic-resistant varieties, may have had a different origin from tobacco varieties that are susceptible to mosaic.

Controlling sucker development in tobacco.—Maleic hydrazide, 30 percent in diethanolamine-water, was tested as a means of preventing sucker development in tobacco. It was used both in the greenhouse and in the field. Terminal growth was stopped without effect on the spread of leaves when sufficient material was applied. The sprayed leaves under these conditions become chlorotic and the growing point milky in color.

Plants sprayed at first appearance of flower buds dropped the buds and produced no seed. Growth of all suckers or lateral shoots sprayed was completely stopped, but there was little or no evidence of translocation of the material within the plant to retard growing points not directly sprayed. Lower concentrations caused decreasingly less effects. Plants growing in the greenhouse, when sprayed, sometimes developed several very narrow leaves but finally resumed normal growth, suggesting that there had been no effect on the inheritance mechanism of the plant. If means could be worked out for application of the material to all growing points, the material might have value as a means of controlling sucker growth in tobacco.

Injury to tobacco leaves from corn pollen.—On several occasions commercial crops of tobacco growing near corn have been injured considerably by a leaf spot different from those commonly recognized. On one occasion Ky 41A nearing maturity was seriously damaged. Ky 34 and Ky 35 have both been injured seriously and appeared to be more susceptible to injury than other varieties. In 1949, when corn pollen was dusted on leaves of susceptible varieties, small orange or red spots developed after 5 to 10 days. The older the leaf the sooner the spots developed. The spots were at first chlorotic, then orange or yellow, then red or brown, and finally bleached to white. In these tests Ky 34, and Ky 35 which was derived from it, were much more susceptible than Ky 16, which appeared to be almost immune.

Reaction of species of *Nicotiana* to streak virus.—Fifty-eight species of *Nicotiana* have been described. Seed of 9 of these is unavailable. Of the remaining 49 species, seed germinated very poorly in 3, and 46 have been tested for resistance to streak. Most of the species are susceptible to streak; a few—*N. benthamiana*, *N. clevelandii*, *N. megalosiphon*, *N. miersii*, *N. occidentalis*, and *N. repanda*—are even more susceptible than burley tobacco. A few species offer promise as resistant stock in breeding resistant burley tobacco, especially *N. glauca* and *N. benavidesii*, and perhaps *N. arentsii*, *N. cordifolia*, *N. maritima*, and *N. raimondii*.

Preparation of streak inoculum with Na_2SO_3 .—It has been reported (Phytopathology 39:236) that reducing agents such as Na_2SO_3 incorporated in streak inoculum at the time of preparation prevented aging (deterioration) of the inoculum by eliminating the effect of the inactivating or inhibiting substance present in extracts of tobacco

leaves. These results have been substantiated in our tests: preparation of inoculum from chronically infected leaves of *N. rustica* crushed with M/100 Na_2SO_3 ensured the production of active inoculum consistently. The presence of Na_2SO_3 seems to eliminate the inhibiting effect produced by thorough grinding of inoculum. covered
by 29, 13

Aging of tobacco streak virus.—It has been reported (Phytopathology 39:234) that aging for as short a time as 20 minutes inactivates streak inoculum, presumably prepared by thorough crushing in a mortar. In our tests, inoculum prepared by moderate crushing of chronically infected leaves of *N. rustica* with M/10 Na_2HPO_4 did not deteriorate greatly after aging for as long as 5 hours at room temperature. Similar inoculum prepared with M/100 Na_2SO_3 was still virulent after storage 3 days at 4° C.

Dilution of streak inoculum.—Streak inoculum prepared from chronically infected leaves of *N. rustica* with M/100 Na_2SO_3 can be diluted with four parts of M/100 Na_2SO_3 without reducing the number of local lesions that develop on tobacco leaves rubbed with the inoculum, indicating that the original inoculum has more infectious units than can be detected by the local lesions method. Dilution of the original inoculum with M/100 Na_2SO_3 , distilled water, and healthy tobacco juice produced the following average numbers of local lesions respectively on 16 cm² of rubbed tobacco leaf: no dilution—230, 240, 225; diluted 1:2—230, 240, 80; diluted 1:4—230, 170, 15; diluted 1:8—200, 125, 2; diluted 1:16—140, 85, 0; diluted 1:32—100, 45, 0; diluted 1:64—60, 20, 0; diluted 1:128—40, 10, 0. These results suggest that inoculum diluted 1:2 with water would be a better test for determining the inhibiting effect of preparations of healthy juice than undiluted inoculum, inasmuch as the titer of the undiluted inoculum might be reduced considerably without a reduction in detectable local lesions.

Reaction of species of *Nicotiana* to tobacco mosaic virus.—Fifty-eight species of *Nicotiana* have been described. Seed of 9 of these is unavailable. Forty-four of the remaining species have been tested for resistance to mosaic. Mottling or mosaic was the dominant symptom in 17 species, and in some plants of 4 other species. Yellowing and stunting, often with mottling or with necrosis, was the chief symptom in 8 species. In 2 species mild mottle developed in some plants while others were symptomless. In one species distortion occurred without mottling. One species showed no symptoms at all. Local necrotic spots often followed by systemic necrosis occurred in 5 species, and in some plants of the 4 species mentioned above. Local necrotic spots without subsequent systemic infection developed in 6 species.

Inoculation of tobacco with *Fusarium*.—*Fusarium* wilt or yellows of tobacco appears to be increasingly more common. Inasmuch as available resistant burley varieties such as Ky 35 are not entirely immune, more resistant breeding stock is desirable. A method of inoculating rapidly and consistently large numbers of plants, especially in the early stage of growth, would be useful in testing for resistance.

Germinating seed and young seedlings dipped into a spore suspen-

sion and then allowed to grow in nutrient solution did not show symptoms of infection. Germinating seed and young seedlings placed on agar cultures of *Fusarium* did not develop typical symptoms, but eventually became smothered by the fungus. Placing spore suspensions in sandy soil in which seed was sowed did not produce infection, but when these plants were later potted some developed typical fusarium yellows. These tests suggest that either the plants do not become infected without root injury or the young seedlings under these conditions were not growing vigorously enough to develop acute symptoms.

Young susceptible plants (Ky 56) injected with a spore suspension developed symptoms in 3 or 4 days. In some cases the plants were killed; in other cases they recovered. These symptoms seem to be produced by the fungus rather than by injected toxin, because (1) the symptoms did not develop in plants injected with inoculum that was boiled or passed through a Seitz filter, and (2) young (48-hour) cultures in which much toxin could not have accumulated caused symptoms.

New strains of viruses in tobacco.—An unidentified virus (accession number 4) was isolated from a tobacco plant on the Experiment Station farm in July 1949. It seemed to have a similarity in symptoms to a yellow strain of ring spot, but in the greenhouse does not produce typical ring-spot patterns, and is distinct from two other known strains of ring spot—one mild and one severe. It produces local lesions and systemic infection in *Amaranthus globosum*. The host range is being determined.

Another unidentified virus (accession number 10) was isolated from a plant infected with streak in the greenhouse, inoculated with streak from a plant on the Experiment Station farm in July 1949. It seems to be different from any of the common strains of known viruses on tobacco. The host range is being studied.

A strain of streak isolated from a tobacco plant on the Experiment Station farm in July 1949 that was believed to be mixed with some other virus has been inoculated onto *Amaranthus globosum* and recovered from local lesions. On tobacco it seems to produce more chlorosis and less necrosis than the common strain.

Control of wireworm injury to newly set tobacco plants.—Insecticides, as wettable powders, were mixed in the "setting water" and the plants were set by a machine adjusted to deliver $\frac{3}{4}$ pint of the mixture to each plant. Each treatment was replicated four times and there were four untreated plots. On the treated plots the insecticides, mixed in 50 gallons of the "setting water" reduced the number of plants injured, as compared with the number injured on untreated plots, as follows:

Parathion, 25-percent powder	Percent
1 oz	59.3
2 oz	74.8
Chlordane, 8 oz, 50-percent powder	64.1
Compound 118, 6 oz, 25-percent powder	44.7
Gamma benzene hexachloride, 25-percent powder	
1 oz	59.9
2 oz	66.0

None of the treatments caused any apparent injury to the plants.

Effects of topping, suckering, and priming upon yield, quality, and income of burley tobacco.—In an experiment run in quadruplicate (all plots harvested when mature) the average per-acre yield, dollar returns, and the labor requirement for the various treatments in 1948 are given below. The treatments were (1) not topped or suckered until cut, primed; (2) not topped or suckered until cut, top leaves stripped from seedhead down to normal topping height, primed; (3) topped but not suckered until cut, primed; (4) topped, suckered two times, primed; (5) topped, suckered two times, not primed.

<i>Treatment</i>	<i>Yield, lb</i>	<i>Per acre</i>	<i>Value Per 100 lb</i>	<i>Man- hours¹</i>
1	1963	\$1,101	\$56.11	286.9
2	1991	1,056	53.03	303.5
3	2206	1,190	53.93	306.4
4	2162	1,151	53.24	312.8
5	1872	961	51.47	234.2

¹ Labor required to top, sucker, prime, stalk cut, and strip ready for market. Other labor operations are uniform for all plots and not included in the total.

Highest per acre return and yield was from treatment 3; lowest from treatment 5. Highest value per 100 pounds and also largest yield of smoker tobacco was produced with treatment 1. Highest income judged by the return per acre less the production cost was from treatment 3. Priming increased the labor by 73 man-hours per acre. However, the increased value for priming was \$190 per acre, or \$2.60 per hour of priming (comparing treatments 4 and 5, which were equal except for priming). These results are for one year; different seasonal conditions may modify the results.

Income from burley tobacco in relation to harvest methods and maturity.—Effect of maturity of unprimed tobacco at harvest varied with seasonal conditions at cutting time. Income per acre of tobacco increased \$247 in 1945 and \$234 in 1946 from early to mature harvest. In 1947, a more humid year than 1945 or 1946, the midseason harvest increased the value \$40 per acre while mature harvest was \$13 greater. There was no appreciable labor difference for the three stages of harvest.

Maximum yield, price, and income were obtained by two primings in 1945 and 1946. One priming increased the yield 157 pounds and income \$85 per acre. The second priming gave a further increase of 130 pounds and \$70 per acre. Average price decreased significantly for the fourth priming in 1946. One priming in 1947 increased yields 303 pounds and \$139 per acre while a second priming further increased yield and value by 216 pounds and \$136. Maximum income was obtained with three primings in 1947, although the third priming was uneconomical where the labor wage was over 60 cents per hour.

Average man-hours required to prime an acre of burley tobacco from one to four times were 65.5, 117.9, 164.2, 170.7 hours respectively. Average returns for labor expended in 1945 and 1946 were \$1.30 for one priming and \$1.32 for two primings. In 1946, average return was \$0.82 for three primings and \$0.39 for four primings. When leaf loss in tobacco not primed was high (1947), the returns for one to four primings were \$2.12, \$2.33, \$1.85, and \$1.60 per hour respectively.

Burley tobacco grown in continuous culture and in a 2-year rotation.—Experiments are being conducted on the Campbellsville and Greenville experiment fields comparing burley tobacco grown continuously and in a 2-year rotation. The continuous tobacco is followed with a cover crop of small grain and vetch, while the 2-year rotation is followed by small grain, red top, and red clover which is kept clipped as though pastured. All the plots have been limed. The results obtained were:

	Acre-Yields where Treatments per acre were—	
	120 lb N, 120 lb P_2O_5 , and 120 lb K_2O	10 tons Manure and 60 lb P_2O_5
	lb	lb
At Campbellsville (average, 4 years, 1946-49)		
Continuous tobacco	1,426	1,414
Tobacco in 2-year rotation	1,799	1,554
At Greenville (average, 3 years, 1946-48)		
Continuous tobacco	1,655	1,495
Tobacco in 2-year rotation	1,783	1,650

Growers' losses on high order tobacco.—During the 1948-49 marketing season about 24 million pounds of burley tobacco were graded "W" (containing enough moisture to be in doubtful keeping order) and about 6 million pounds were graded "U" (indicating un-sound condition, often resulting from excess moisture at some stage in curing or preparing for market). Burley growers received approximately \$2,400,000 less for this tobacco than it would have brought if it had been in normal sales order. Though conditions of temperature and humidity during the 1948-49 marketing season made it difficult to keep burley tobacco in good order, much of this loss could have been prevented by proper care in curing, bulking, and delivery to market.

Price discounts on burley tobacco graded "W" ranged up to \$20 per 100 pounds on some grades. Largest losses in price per 100 pounds occurred in the low, 5th quality, Flyings, Lugs, and Tan Leaf. Losses ranged from 15 to 30 percent on nearly all grades. Weighted average discounts on tobacco graded "W" were \$14.29 for lugs, \$11.26 for Flyings, \$8.26 for Leaf and \$3.69 for Tips. Discounts on "U" tobacco were even larger.

Easier, faster methods of packing tobacco for sale.—In an analysis of work methods in tobacco sales warehouses in Kentucky, aimed at improving marketing efficiency, it was found that nearly half the labor used in the warehouses is given to packing the tobacco on baskets, and that workers following the best of the methods in use can do the work in about half the time taken by the less efficient methods.

Price differences between tobacco sales of like grade.—In a study of 60,000 basket sales of burley tobacco, 40 percent of the sales were priced more than \$2 above or below the market average for the same grade sold in the same warehouse on the same day. These price differences varied widely between grades of tobacco. Less than 1 percent of fine quality tan lugs (C2F) were priced more than \$2 above or below the daily grade average price, as compared to 46 percent of

the low quality red lugs (C5R). In low quality leaf and tips of red and green colors the prices were \$15 and even up to \$20 from the daily grade average price.

The baskets of high quality and light color were highly uniform in price from day to day throughout the marketing season. For the lower grades, however, the pricing system was much less effective in determining somewhat near the same prices for the same qualities.

Relation between plant population and yield of corn at Mayfield.— The effect of plant population on yields of corn was studied on different levels of fertility at the Mayfield soil field from 1946 through 1949. The population per acre on half of each plot in the experiment was 7,400 plants and on the other half, 11,200 plants. Average acre-yields for the 4-year period were:

	7,400 Stalks per acre	11,200 Stalks per acre
Under 40 bushels per acre, 1 plot	27.9 bu	24.3 bu
40-50 bushels per acre, ave., 3 plots	46.0	45.7
50-60 bushels per acre, ave., 4 plots	53.0	52.5
60-70 bushels per acre, ave., 6 plots	62.8	65.2
70-80 bushels per acre, ave., 7 plots	70.8	77.8
Over 80 bushels, 1 plot	76.4	87.1

On plots where the yield was under 50 bushels the heavier stand produced more nubbins and other inferior corn than the lighter stand. The heavier stand was advantageous only where yields were above 60 bushels per acre.

Similar results were found in a study of rates of planting and yields of corn on 51 farms. The optimum rate of planting to obtain best yield was 210 mature plants *per bushel* on land which produced less than 40 bushels per acre, and 133 mature plants *per bushel* on land producing more than 50 bushels per acre. Land producing 30 bushels per acre would need about 6,000 plants per acre, and land producing 75 bushels per acre would need about 10,000 plants per acre.

Control of weeds in corn with chemicals.— One set of quadruplicated plot tests at the Experiment Station in 1949, where sprays containing 0.4 pound of 2,4-D acid (amine form) in 121½ gallons of water per acre were applied when corn was about 6 inches high to control early weeds, and where a late cultivation was made when corn was about 36 inches high to control late weeds, produced 97.3 bushels of corn per acre. Plots cultivated when the corn was 6 inches high and again when 36 inches high produced 96.9 bushels per acre. Where the reverse combination of early cultivation and late spraying was used, the yields were 12 bushels less. The late cultivation is needed to destroy grassy weeds, such as crabgrass, which 2,4-D does not kill. Plots receiving 2 pounds of amine 2,4-D as a preemergence spray on the soil 2 days before the corn emerged, to control early weeds and grasses, and a late cultivation when corn was about 3 feet high, produced 97.3 bushels per acre also. Preemergence spraying without the late cultivation permitted grass and weed competition late in the season and resulted in yields 18 bushels lower than preemergence spraying followed by late cultivation. Plots kept free of weeds by scraping with a hoe produced the same yield of corn as the clean-

cultivated plots. On unsprayed, uncultivated plots the competition by weeds reduced the yield of corn to 38.1 bushels.

The ester form of 2,4-D was appreciably more effective for weed control than the amine, sodium salt, or micronized forms used at equivalent rates of 2,4-D acid in preemergence spraying, and somewhat more effective than the amine form in postemergence spraying. In neither case, however, was the difference in yield of corn significant.

Calcium cyanide applied broadcast at the rate of 300 pounds per acre after corn was planted did not control weeds perceptibly.

Tolerance of corn inbreds to 2,4-D.—The inbred lines used in hybrids certified in Kentucky were tested in replicated plots for tolerance to both preemergence and postemergence applications of 2,4-D at the Experiment Station farm at Lexington in 1949. Two pounds of 2,4-D acid in amine salt form in 12½ gallons of solution per acre was applied to the preemergence plots 5 days before the corn emerged and 0.4 pound of 2,4-D acid in amine form in 12½ gallons of solution per acre was applied to the postemergence plots when the corn was 8-10 inches high. Weeds in the control plots were chopped out periodically. Good weed control was obtained by the preemergence spraying until late June, when crabgrass and nutgrass began coming in. Good control of broad-leaved weeds was also obtained with the postemergence spraying until the latter part of June. All plots were cultivated on June 28 and the larger weeds chopped out following tasseling.

Only Ky 27 showed any marked reduction in emergence from pre-emergence treatment, but Kys, WF 9, Hy, Ky 21, Ky 27, and Ky 49 had a higher percentage of weak plants at emergence in the preemergence plots than in the clean-cultivated plots. Average yields of all inbreds on the postemergence plots was significantly lower than on the clean-cultivated plots, showing the effect of early weed competition. Inbreds 33-16, K 4, and L 317 were affected most by this competition. WF 9 and Ky 27 were significantly lower yielding on the preemergence plots than on the clean-cultivated plots, apparently because of reduction in stand resulting from preemergence treatment. There was considerable variation between the inbreds in their response to the different treatments. Ky 21, Ky 27, K 41, and 38-11 had a higher percentage of broken stalks in the postemergence plots than in the preemergence and clean-cultivated plots. A number of inbreds also had a higher percentage of dead stalks in the postemergence plots. Hy, Ky 49, Ky 122, K 64, and US 13 were affected most by the postemergence spraying of 2,4-D. Those effects were evident in fusion and proliferation of the brace roots.

Self-pollinated inbred seed from the different treatments was tested for germination in sand in the greenhouse. Ky 27, Kys, and K 4 from the preemergence plots all had a lower germination than seed from the clean-cultivated plots, and Ky 122 from the postemergence plots had lower germination than seed from the preemergence and the clean-cultivated plots.

Resistance of corn inbreds and hybrids to breakage from European corn borer.—Eighteen inbreds, 40 single crosses, 9 three-way crosses, and 29 hybrids were grown in a replicated test in Jefferson

county to determine resistance to breakage from European corn borer. No counts were made of the total number of borers per stalk, but counts indicated an average of at least five punctures per stalk. Nine of the 18 inbreds had a low percentage of breakage below the ear resulting from corn borer punctures. These inbreds apparently transmit resistance to breakage in single crosses, for breakage was greater where susceptible inbreds were involved. The resistance of these inbreds was evident also in three-way crosses with a common tester parent. A number of double-cross hybrids involving resistant inbred lines had low percentages of breakage. Considerable breakage from borer puncture occurred above the ear-bearing node, but in this character there were no great differences among the inbreds or hybrids. Breakage from borer punctures was highly correlated with total breakage. Selections can therefore be made for resistance to total breakage with good assurance of obtaining resistance to breakage from borer punctures.

European corn borer development in Kentucky.—A fall survey was made in 1949 to determine the abundance of European corn borer in nine counties which had been studied in previous years. In general corn borer abundance remained unchanged when compared to 1948. Fayette and Jefferson counties showed the most marked changes, having 12 and 127 borers per 100 stalks respectively in 1949, as compared to 40 and 162 in 1948. Jefferson county still was the most infested of those studied.

Mortality of overwintering borers was again light in 1949, averaging less than 10 percent. Pupation began in early May and the first moths emerged May 27. Egg laying began May 30 at Lexington and continued during the first 2 weeks of June. Egg deposition was light in Fayette county in comparison with that of previous years. Jefferson county had a comparatively heavy first-brood egg deposition.

Pupation of first-generation borers began July 1 in early planted sweet corn and July 10 in early planted field corn. At Lexington 81 percent of the first-generation larvae had pupated by July 22 in early field corn and 92 percent in early sweet corn. Moth emergence began July 10 in early sweet corn and July 20 in early field corn. At Louisville moth emergence began July 13 in early field corn.

In general, corn was planted early this year. Ordinarily this would make conditions more favorable for the survival of first-generation borer than for the second. Observations in Jefferson county indicated, however, that the first generation did not get firmly established and the ensuing second generation did not reach the proportions of 1948. Both generations were extremely light in Fayette county. Large numbers of first-generation eggs were destroyed by predatory mites; furthermore, a heavy attack by *Lydella* parasites was also an important factor in borer reduction.

European corn borer parasites.—To check on the spread of introduced parasites, corn borer larvae were collected in the fall of 1948 in Warren and Jefferson counties and at 10-mile intervals throughout much of the Bluegrass region. Rearing work by the European Corn Borer Laboratory of the Federal Bureau of Entomology and Plant Quarantine at Moorestown, New Jersey, indicated that the

tachinid fly, *Lydella stabulans grisescens* R. and D., is now well established in Bourbon, Boyle, Fayette, Jessamine, Madison, Mercer, Scott, Warren, and Woodford counties. In Fayette county parasitism by this species averaged 30.4 percent. *Macrocentrus gifuensis* Ashn. was recovered from the Louisville area.

In 1949, 6 colonies of *Chelonus annulipes* Wesn., totaling 1,611 specimens, and 5 colonies of *Macrocentrus gifuensis* Ashn., totaling 7,119 specimens, were released in Fayette and Jessamine counties. These liberations make a total of 48,150 parasites which have been released over the state in recent years. *Lydella stabulans grisescens* continued to appear the most promising of the imported parasites.

Yields of commercial corn hybrids.—Tests of commercial hybrids sold and grown in the Pennyroyal district have been conducted for four years in Todd county in cooperation with the Pennyroyal Grain Improvement Association. Twenty-five hybrids were included in the test in 1949, the average yield of all entries being 99.4 bushels per acre. Some hybrids ranking high in 1948 were lower in yield in 1949; others low in yield in 1948 were high in yield in the favorable season in 1949. The white hybrids in this test outyielded all of the yellow hybrids with the exception of Dixie 44. The white hybrids averaged 107.8 and the yellow hybrids 94.7 bushels per acre. Favorable conditions during 1949 allowed the later-maturing white hybrids to make full use of the growing season.

Nineteen hybrids tested in 1948 were repeated in 1949; 14 have been tested the past three years, and 11 have been tested all four years. Of the 19 hybrids tested the past two years, only Tenn. 10 was significantly better yielding than any of the other white hybrids. Dixie 44, Ky 103, and US 13 were significantly better yielding than other yellow hybrids. There were no significant differences in yield among the white hybrids tested for three years and four years, but Funk G 515W, Ky 203, Tenn. 10, M5, and Ky 405B appear to be satisfactory hybrids. Ky 193 and US 13 were the best yellow hybrids for both the 3-year and the 4-year periods.

Yields of certified and experimental corn hybrids.—Sixteen white hybrids and 10 yellow hybrids were grown in yield tests in Fayette, Todd, Caldwell, Daviess, Jefferson, Breathitt, and Lee counties. In addition several other hybrids were tested in individual locations. The test in Lee county was damaged by hogs; one in Madison county was completely destroyed by cattle. The season, in general, was favorable for corn in all locations, although in some areas dry weather occurred following silking and tasseling. Average yield of the 26 varieties for all locations was 94.8 bushels per acre. In the counties the yields were: Fayette county, 103.0 bushels per acre; Todd county, 101.6; Caldwell county, 83.3; Daviess county, 107.7; Jefferson county, 96.8; Breathitt county, 83.1; and Lee county, 88.4.

The white hybrids averaged 99.2 bushels per acre and the yellow hybrids 89.6. Several white hybrids were higher yielding than the commercial hybrids being certified. An outstanding new white hybrid was Ky 423B (US 523W). This hybrid, or its permutation Ky 423A (US 513W), has been tested for three years in statewide tests and has

been an excellent yielder with good standing ability. This hybrid is later maturing than Ky 203 but will be satisfactory in most areas in Kentucky if it is planted reasonably early. Dixie 17, a prolific late hybrid, was outstanding in yield but lacked standing ability and the ears were high on the stalk. Ky 408, Ky 410, Ky 418, Ky 7109, and Ky 7114 all continued to yield higher than the white hybrids being certified. All the yellow hybrids were generally similar in yield. Dixie 44 continued to outrank other yellow hybrids in yield but is late and high eared. Ky 7001 continued higher in yield and standability than US 13 and Ky 103.

Fertility in relation to premature killing and stalk breakage in corn.—Premature killing, accompanied by excessive stalk breakage, has been evident for the past several years on high-yielding corn plots. More killing and breakage has been observed in corn following legume crops, particularly alfalfa, which are heavy feeders on potash. Several corn hybrids have been grown for the past two years on varying levels of fertility at Lexington and at the Greenville soil experiment field and records made of the amount of killing and breakage.

Low amounts of premature killing accompanied low yields. However, the amounts of premature killing did not increase proportionately as yields increased if all the necessary elements were supplied, until extremely high yield levels were reached. At Greenville, on plots which received no phosphate and were low in available phosphorus, the amount of premature killing and the yields were very low. At both Lexington and Greenville additions of potash increased yields and reduced the amount of premature killing and breakage. Yields at Lexington increased progressively and amount of premature killing decreased progressively as nitrogen was increased, until yields were above 100 bushels per acre, when premature killing began to increase. Apparently other factors, such as shortage of moisture, entered in at the higher yield levels.

Profitable rates for fertilizing corn.—Information was obtained on 51 farms where an 8-8-8 fertilizer was used at three different rates of application, for corn production. The corn produced was valued at \$1.20 per bushel, and cost of fertilizer was \$58.20 per ton. The cornland was mostly level or gently rolling upland and creek bottomland, suitable for corn production in a short rotation. On these farms different rates of planting were also used, and the following data were obtained with the optimum number of plants per acre, at the given fertility levels.

<i>Fertilizer (8-8-8) broadcast per acre</i>	<i>Value of increased production above cost of fertilizer</i>
On land producing 30 bu corn or less, per acre, without fertilization	
625 lb	\$14.81
625 lb more (total, 1,250 lb)	1.13
625 lb more (total, 1,875 lb)	-7.27
On land producing 50 to 60 bu corn, per acre, without fertilization	
625 lb	13.97
625 lb more (total, 1,250 lb)	4.85
625 lb more (total, 1,875 lb)	-5.83
On land producing 80 to 95 bu corn, per acre, without fertilization	
625 lb	-10.75
625 lb more (total, 1,250 lb)	-6.67
625 lb more (total, 1,875 lb)	-15.55

On the whole, based upon the averages of all yield levels, the increased corn production when valued at \$1.20 a bushel was worth more than the cost of the first 625 pounds of fertilizer. If corn were \$1.50 per bushel, the additional corn produced would have more than paid for another 625 pounds of fertilizer. However, only on land of the lower levels of productivity without fertilization would the use of a third 625 pounds of fertilizer have produced enough corn, even at \$2 per bushel, to have paid for this much fertilizer, on these farms in 1949.

Inheritance of male sterility in corn hybrids.—The causes and nature of male sterility in certain white hybrids and the resulting poor set of seed have not been completely ascertained. Crosses made using 33-16 as the seed parent and backcrossing to 33-16 three times continued to exhibit male sterility, whereas in using 33-16 as the pollen parent in making the original cross and backcrossing to 33-16 three times, the plants have been normal, showing that male sterility is carried in 33-16, apparently through the cytoplasm.

Hybrid popcorn.—Four popcorn hybrids in commercial use were compared with five Kentucky experimental hybrids in tests at Lexington and Owensboro. Yields at Lexington averaged 4,586 pounds of ear corn per acre, and at Owensboro 3,347 pounds. The experimental hybrids were satisfactory in popping quality, but did not come up to the commercial hybrids in yield. Purdue 3 was the highest yielding hybrid at both locations, but the differences in yield between it and Purdue 31, Purdue 32, and Purdue 38 were not significant.

In an additional test at Lexington, three Purdue experimental hybrids proved to be equal to or better yielding than Purdue 32, Purdue 38, and Purdue 31. These new hybrids also stood up well and had good popping quality.

DDT-impregnated cotton bags for protecting stored corn from insects.—Cotton bags were dipped in or sprayed with solutions containing $2\frac{1}{2}$, 5, and 10 percent of DDT dissolved in carbon tetrachloride and were filled with corn after the carbon tetrachloride had evaporated. Four bags were dipped and four were sprayed with each of the three solutions, and four bags were untreated. The treated bags and the checks were placed in trays containing corn infested by Angoumois grain moth, Indian meal moth, confused flour beetle, lesser grain beetle, and other insects. After 18 months storage the percentages of infestation were 8 percent, 4 percent, and 3.9 percent, respectively, in the bags dipped in the three solutions; and 6 percent, 4.7 percent, and 3.6 percent in the sprayed bags. In untreated bags the infestation was 89.7 percent after 18 months.

Control of green June beetle grubs in soil.—Benzene hexachloride at the rate of 2 pounds per acre of gamma isomer (high gamma BHC) and parathion at 3 and 4 pounds per acre were used in the spring of 1949 in tests to control green June beetle grubs. Each treatment was replicated four times and there were four untreated plots. These chemicals were worked into the soil to a depth of 2 inches, except one set of four plots where 4 pounds of parathion was broadcast on the surface of the soil and then sprinkled with water. The

average control for the 2 pounds gamma BHC was 84.4 percent. The 3 pounds of parathion gave a control of 94.8 percent. In plots where 4 pounds of parathion were worked into the soil an average of 93.8 percent of the grubs were killed, and where 4 pounds of parathion was broadcast on the soil and sprinkled with water, an average of 91.6 percent of the grubs were killed.

Pasture irrigation in Kentucky.—In June a pasture irrigation experiment was established in a permanent pasture on the Experiment Station farm at Lexington. Available phosphate was high and available potash very low for each field. The soil in each field averaged about pH 5.5. Herbage consisted of Ky bluegrass, orchard grass, white clover, and considerable weeds and wild grasses. The area was divided into four 1-acre fields. Two of the fields were irrigated. One of the irrigated fields and one not irrigated received a 25-pound application of nitrogen in July and another in September. Irrigated fields received an acre-inch of water immediately following any 10 consecutive days in which there was less than 0.20 inches of rainfall in any 24-hours or a total rainfall of less than 1 inch for the period.

With the exception of 1945, the distribution of rainfall at Lexington in 1949 was the best in a 20-year period studied. There were only three periods of drouth from June 12 through September 8 in 1949. In each instance substantial rain fell before irrigation could be completed. Total irrigation in 1949 amounted to 2.5 inches of water per acre. It was applied with perforated pipe.

Yields were obtained by grazing and by clipping. Cows in full production were placed on the pastures on July 11 and removed September 8, and yields were calculated in terms of total digestible nutrients per acre. Beginning June 12, herbage was cut to a height of 1 inch from ten 4' x 4' wire cages per field each time it attained a height of 4 inches, and the cages were then moved to a new clipped area. The last clipping was on September 19.

Total yields obtained by grazing and clipping methods were 42 and 35 percent larger respectively from nitration than from no nitration, and 72 and 22 percent larger respectively from irrigation than from no irrigation. Yields from nitration and irrigation together were 77 and 60 percent larger than from no treatment.

A similar experiment was conducted on a permanent pasture 13 miles south of Mayfield. Herbage was mainly Ky 31 fescue, orchard grass, red clover, and certified Ladino clover. Available phosphate was medium, available potassium was very low, and pH was 6.1; therefore 200 pounds of muriate of potash and 50 pounds of P_2O_5 were applied per acre. Rainfall during 1949 was the best over a 21-year period, excepting two years, 1929 and 1940. In three irrigations, approximately 3 inches of water was applied per acre, total. The following yields were obtained:

<i>Treatment</i>	<i>Yield, pounds of dry matter per acre</i>
None	6448
Nitrated	7843
Irrigated	7683
Irrigated and nitrated	8357

Significant difference at 5% level, 1246 pounds.

Significant difference at 1% level, 1678 pounds.

Effect of different amounts of ammonium nitrate applied at different seasons on permanent pasture.— In 1948, an experiment was begun at Hodgenville to determine the best rate and season or combination of seasons for the application of ammonium nitrate to produce the greatest yield from permanent pasture. The experimental field received a basic application of 200 pounds each of K_2O and P_2O_5 , and 2 tons of limestone per acre. No subsequent application of these materials has been made. Yields were obtained by clipping herbage (principally orchard grass, redtop, and lespedeza) to a height of 1 inch each time it attained a height of 4 or 5 inches. Ammonium nitrate was applied at the rate and season shown in the following table, which also shows the yields for 1949.

Treatment		Yield	
Time of season applied	Nitrogen applied, pounds per acre	Total pounds of Dry matter per acre	Rank
March 28	40	3179	5
June 28	40	3166	6
September 9	40	3287	4
March 28	20 \	3324	3
September 9	20 f		
March 28	40 \	3916	2
September 9	40 f		
March 28	26.7 \		
June 28	26.7 }	4190	1
September 9	26.7 }		
None	None	2863	7

Significant difference at 5% level = 81.3 lb per acre.

Significant difference at 1% level = 110.6 lb per acre.

Surface versus subsurface placement of phosphatic fertilizers for pastures.— In experiments established near Mayfield, Greenville, and Hodgenville in 1947 for comparing the effects of surface and subsurface placement of various phosphatic fertilizers and ground limestone on dry-matter yields of permanent pastures, no advantages have been found for either method of placement over the other. Yields have averaged approximately the same. The subsurface treatments were placed by a special machine 4 inches beneath the sod in rows 8 to 12 inches apart and the surface treatments were applied as top-dressings. No applications were made in 1948 or 1949. Likewise, disregarding the method of application, there were no significant differences in results from the different kinds of phosphatic fertilizers used, though the yields from plots receiving identical rates of P_2O_5 from super, triple super, and fused tricalcium phosphate application, were somewhat higher than those receiving the same rate of P_2O_5 from meta phosphate and those receiving twice the rate of P_2O_5 from rock-phosphate applications.

Using barn manure on bluegrass pasture.— During the winter of 1949, an area of permanent pasture was fenced into four fields of 2.9 acres each. The four fields were treated with 0, 3, 5, and 8 tons of well-rotted barnyard manure per acre respectively on April 8th. The manure contained 1.75 percent nitrogen. This was the only fertilizer treatment applied during the year. The manure was dragged to spread it evenly over all of the treated fields and droppings were scattered by

dragging twice during the summer. Analysis of soil samples showed available phosphorus to be high and available potassium to range from very low to low in all fields. The soil in each field averaged about pH 5.5.

Herbage consisted principally of Ky bluegrass and white clover. Grazing and clipping methods were used to obtain yields. The fields were grazed with Jersey and Holstein heifers. Yields were calculated from the maintenance and gain of the animals in terms of pounds of total digestible nutrients per acre. The number of animals placed on each field was controlled by gain or loss in weight of animals and the amount of herbage present during the various periods of the season. Grazing began on May 6 and ended on October 8.

Herbage was clipped to a height of 1 inch from ten 4' x 4' wire cages per field each time it attained a height of 4 inches, and the cages were then moved to another clipped area. Yields as calculated by the two methods of determination were as follows:

Treatment, tons of manure per acre	Pounds of total digestible nutrients per acre	
	Grazing	Clipping*
None	2,567	2,322
3	2,722	1,673
5	2,440	1,871
8	2,476	1,611

* One entire clipping was discarded as several of the cages on two fields were turned over by the heifers.

Effect of top-dressing potassium fertilizer on permanent pasture yields.—During the fall of 1948, a potassium experiment was begun on an established permanent pasture on the Experiment Station farm at Lexington. The soil was very low in available potassium, high in available phosphate, and averaged pH 5.6.

Herbage consisted of Ky bluegrass, orchard grass, white and hop clover, and considerable weeds. Plots were 1/120 of an acre. Each treatment was replicated four times. The 1949 yields obtained from five clippings were harvested by clipping the herbage to a height of 1 inch each time it attained a height of 4 inches. Plots receiving 60 and 120 pounds of K_2O per acre in the form of muriate of potash did not yield significantly different from the no-treatment plot. The yield produced by an application of 120 pounds of K_2O and 30 pounds of N per acre was significantly higher than that obtained from untreated plots and from plots treated with 60 to 120 pounds of K_2O per acre.

Combined spray application of 2,4-D and chlordane on Ladino clover and fescue.—To control ragweeds in spring-seeded mixture of Ladino clover and Ky 31 fescue and to kill grasshoppers infesting the crop, amine 2,4-D at the rate of 1 pound of acid and emulsifiable chlordane at the rate of 1 pound of active ingredient were applied in 10 gallons of water per acre, with a low-pressure power sprayer. The treatment resulted in an excellent kill of grasshoppers and the gradual dying of ragweeds over a period of several weeks. There was no apparent difference in the effectiveness of 2,4-D where used in combination with chlordane and where used alone on an adjacent area of the

same field. The Ladino clover was injured only slightly by the 2,4-D even where the taller growth of ragweeds did not shield it from the spray. Both the clover and the unharmed Ky 31 fescue made excellent growth during the summer. (Chlordane should not be used on fields where livestock are to be pastured sooner than 3 weeks after treatment.)

Tests with mulch drill for seeding small grain crops in sod.— In a test in Trigg county, wheat seeded after lespedeza, on a well-prepared seedbed, produced 21.7 bushels of grain per acre — about 4 bushels more than wheat sowed in lespedeza sod, without previous preparation, by means of a drill equipped with special furrow openers developed by the Tennessee Valley Authority. Observed advantages of mulch seeding not reflected in the comparative grain yields were the added protection against soil erosion provided by the lespedeza sod and firmer ground condition for winter grazing of the small grain.

Composition of forage crops grown in Kentucky.— Analyses of many samples of legumes and grasses grown under different conditions in widely scattered areas of Kentucky during 1948 and 1949 varied greatly. Variations between forages grown on fields in one locality and on one soil type were as great as those between forages from widely separated parts of the state. Ranges and averages for alfalfa were as follows (pounds per ton of dry matter):

	<i>Phosphorus</i>	<i>Potassium</i>	<i>Calcium</i>	<i>Magnesium</i>	<i>Nitrogen</i>
Range	4-11	14-56	21-47	3-13	49-105
Average	7	34	32	6	73

Similar variations were found for Kentucky bluegrass, orchard grass, tall fescue, hop clover, red clover, and sweet clover.

Alfalfa varieties.— Two lots of Argentine alfalfa sown in August 1945 produced 2,978 and 3,180 pounds of dry matter per acre from two cuttings. Buffalo produced 4,044 pounds; Ranger, 4,182; Hardigan, 4,399; Kansas Common, 3,277; Kentucky 41, 3,897; two lots of Oklahoma Common, 3,313 and 3,511; and Atlantic 4,727.

Crimson clover varieties.— Crimson clover varieties sown September 2, 1948, on the Experiment Station farm at Lexington, produced from one cutting made May 12, 1949, the following pounds of dry matter per acre: Dixie, 3,531; Auburn Reseeding, 3,180; Tennessee Commercial, 3,196; and four lots from western Kentucky, 3,183, 3,348, 3,422, and 3,537.

White clover varieties.— White and Ladino clover strains sown in September 1947 produced from one cutting made September 9, 1949, the following pounds of dry matter per acre: Central Kentucky white, 487; Western Kentucky white 1,015; Kentucky Certified Ladino, 870; Oregon Certified Ladino, 967; and Commercial Ladino, 790.

Kenland red-clover yields.— Twenty-three lots of Kenland red clover produced 3,123 to 4,090 pounds of dry matter per acre from two cuttings. These lots represented different seed generations, stands of

different ages, and seed from different regions. Only three of the lots produced more than 4,000 pounds; they were from seed produced on the Experiment Station farm.

Control of insects affecting red-clover seed production.— Collections of insects were made from a field of red clover which was to be harvested for seed. DDT was applied at the rate of 32 pounds per acre of a 5-percent dust on July 1, 1949. The tarnished plant bug, *Lygus oblineatus*, which injures the developing seed was the most destructive of the insects found. The DDT killed 78.7 percent of this bug. The potato leafhopper, which sometimes severely injures clover plants, was present in the collections in small numbers. The DDT treatment was effective in killing 81.1 percent of this leafhopper. The bee pollinators appeared to be repelled by the DDT, but within a few days there was no real difference between numbers of bees on the treated and untreated parts of the field.

Effect of DDT on seed yields of red clover.— A plot of Kenland red clover treated in the early bloom stage with 5-percent DDT dust at the rate of approximately 35 pounds per acre for the control of harmful insects produced 306 pounds of seed per acre. The yield of the untreated (check) plot was 241 pounds.

Effect of grasses as companion crops on yields of red-clover seed.— In order to determine the effect of grasses as companion crops on the seed production of red clover, plantings of Kenland red clover alone and with Kentucky bluegrass, timothy, redbud, orchard grass, and Ky 31 fescue were made in April and August, 1948. The seed yields in 1949 were not significantly increased by any of the companion grasses. They were significantly reduced by orchard grass in both plantings, by Ky 31 fescue in the spring planting, and by timothy in the fall planting.

Effect of solid planting and row spacings on red-clover seed production.— Broadcast seedings at the rate of 12 pounds per acre were compared with seedings in rows spaced 6, 12, 18, 24, 30, and 36 inches apart. About 1 pound of seed per acre was seeded in the wider rows; and up to approximately 2 pounds in the narrow rows. Yields of seed per acre from plantings made April 26 and August 31, 1948, were 239, 293; 216, 304; 172, 283; 121, 293; 120, 273; 101, 248; and 97, 238 pounds, respectively. These yields indicate the possibilities of row plantings for the rapid increase of small amounts of red-clover seed in Kentucky.

Effect of the time of cutting the hay crop on seed yields of red clover.— Cuttings of the first crop were made at approximately 10-day intervals from the time of first bloom, May 12, through July 12. The date at which the first crop was cut for hay had a large effect on seed yields of the second crop. The largest yields (346, 334, and 302 pounds of seed per acre) were obtained from the second crop when the first crop was cut June 1, May 26, and June 12. Yields of seed from cuttings made at other dates ranged from 54 to 278 pounds. The first crop when allowed to mature seed produced only 5 pounds of seed per acre.

Seed production of Ky 31 fescue and orchard grass.— Three

types of seed production experiments involving nitrogen fertilizer top-dressings, various management practices, and broadcast versus row seedings were conducted on sods of Ky 31 fescue and orchard grass during the three years 1947-49.

Ammonium nitrate top-dressings at the rate of 200 pounds to the acre approximately doubled the seed yields of both grasses, in comparison with those on untreated plots. Where excess soil moisture was a factor, however, the 200-pound rate of ammonium nitrate resulted in considerable lodging. Lodging was further increased by making the nitrogen top-dressings late in the season (April 1 or later). Another disadvantage of nitrogen top-dressings was a tendency to lower somewhat the test weight per bushel. A 100-pound rate of ammonium nitrate fertilization in general had little effect upon the yields of the first seed crop.

Early spring applications of nitrogen fertilizer were superior to autumn top-dressings for orchard grass, while on fescue sods autumn and spring applications (except that in April, which was too late) were equally effective.

Management practices involved clipped versus unclipped sods, and burning. In the third year of the tests, moderate clipping of the sods in the last half of the year preceding the year of seed harvest resulted in a 50-percent reduction in seed yields, as compared with those on unclipped plots. Burning the sod in late winter had no pronounced effect on seed yields.

Row seedings were highly superior to broadcast seedings for seed production. Row seedings of Ky 31 fescue consistently out-yielded broadcast seedings in all three years of the test. The orchard grass row seedings were superior in only the first two years and dropped to the level of the broadcast seedings in the third year. A 3-pound rate of broadcast seeding of Ky 31 fescue was distinctly superior to a 7-pound rate on the basis of seed yields, and the 7-pound rate was superior to the 15-pound rate. The same relationship existed for orchard grass in 1947 and 1948, but in 1949 the 3-pound broadcast seeding produced a yield similar to that of the 7-pound rate, and both were about 20 percent below the seed yields obtained from the 15-pound rate.

In general, Ky 31 fescue produced greater yields of both forage and seed than orchard grass. Responses to all treatments were approximately the same for both grasses, except for the behavior of the row plantings noted above.

Effect of nitrogen top-dressings on forage yields of tall fescue and orchard grass varieties.—Forage yields of 9 varieties of tall fescue and 10 varieties of orchard grass were compared under conditions of no nitrogen fertilization versus fertilization with 100 pounds of ammonium nitrate per acre after each clipping. The experiments were conducted on 3-year-old sods. The tall fescue yields for two clippings (the third clipping was discarded because of weed content) ranged from 2,422 pounds of dry matter per acre to 3,260 pounds where nitrogen top-dressings were used, compared with 1,544 to 1,815 pounds from unnitrated plots. Yields of the orchard grass varieties

obtained from three clippings ranged from 3,821 to 4,956 pounds of dry matter per acre following the nitrogen top-dressings, and 2,236 to 2,734 pounds where no nitrogen was used. Relative performance of varieties of both orchard grass and tall fescue under the two growth conditions was approximately equal — that is, high-yielding varieties under moderate nitrogen fertilization were also relatively high-yielding varieties where no fertilizer was used.

Orchard grass varieties and strains.—Herbage yields of 23 orchard grass varieties obtained from two clippings ranged from 1,673 to 3,304 pounds of dry matter per acre. The highest yields in 1949 were produced by several old Kentucky strains which had also been highest yielding in the 1948 test. Again in 1949, varieties of English and Canadian origin produced very few stems and panicles and relatively low herbage yields. Varietal differences were significant at the 1-percent level in both 1948 and 1949.

Fescue varieties and strains.—Herbage yields of 14 tall fescue strains obtained from two clippings ranged from 3,135 to 4,012 pounds of dry matter per acre. The highest yields in 1949 were produced by two naturalized strains from Kentucky that had also produced highest yields in 1948. Two strains of meadow fescue included in the test produced 2,508 and 2,722 pounds of dry matter per acre in 1949.

Grass breeding and improvement.—Six new synthetics strains of each of the following grasses were produced in 1949: smooth brome-grass, tall fescue, and orchard grass. Preliminary observations on these new strains in seedlings made in the fall of 1949 indicate that some are making much more early growth than present varieties. Several thousand new individuals of Kentucky bluegrass were established in a fall nursery planting for selection studies.

Interspecific and intergeneric hybridization with grasses.—Greenhouse hybridization work with several species of grasses was continued in the winter of 1948-49. Grasses included were Kentucky bluegrass, tall fescue, smooth brome, ryegrass, timothy, redbud, bermuda, and quackgrass. Approximately 10,000 florets were emasculated for crossing purposes and half of this number treated with α -naphthalene acetamide dissolved in lanolin. Preliminary examination of harvested panicles indicates a number of seeds produced from the tall fescue and ryegrass crosses. It is possible that other crosses will be indicated when the panicle examinations are completed. Future experimental work with this material contemplates the use of colchicine on derived hybrids with the objective of developing fertile hybrids.

Control of the plant bugs *Miris dolobratus* and *Amblytulus nasutus* on Kentucky Bluegrass.—These two bugs were present in injurious numbers in the spring of 1949. Seven dust insecticides were applied by a power duster. Each plot treated was about 1 acre; each treatment was duplicated, and two plots were not treated. Insects were collected before and after the insecticides were applied. Methoxy-chlor, 5-percent dust, applied at 30 pounds per acre was not effective against *A. nasutus*, but it killed practically all *M. dolobratus* by the

end of 10 days. DDT, 5-percent dust, applied at 30 pounds per acre, was almost immediately effective and kept the plots free of the insects for several days. Chlordane, 5-percent dust, applied at 25 pounds per acre gave almost perfect control of both insects. Compound 118, 2.5 percent dust, applied at 25 pounds per acre, killed practically all of both insects within 5 days. Toxaphene, 20-percent dust, 23 pounds per acre, was effective in controlling both plant bugs. Benzene hexachloride (technical), 3-percent gamma isomer dust, used at 25 pounds, was very effective and gave a perfect control for several days. Lindane, 1.5-percent dust, was effective at 30 pounds per acre. A parathion dust containing 2-percent parathion used at 20 pounds per acre was immediately effective and gave perfect control of both bugs. As used in the 1949 tests, all insecticides, excepting methoxychlor, were very effective. The odor of benzene hexachloride and toxaphene was noticeable for about 3 weeks.

Soybean varieties.—In the oil-type soybean variety test at Lexington in 1949, Wabash, a recently introduced yellow soybean variety, produced higher yields of seed than any of the other five varieties. Acre-yields of seed, as an average of six replications for the different varieties, were as follows: Wabash, 39.3 bushels; Ogden, 36.7 bushels; Lincoln, 35.6 bushels; Gibson, 32.2 bushels; Patoka, 29.6 bushels; Macoupin, 24.3 bushels. Wabash is similar to Patoka in maturity and resistance to lodging. The plants average about 8 inches taller than those of Patoka. The lower seed pods are borne well above ground level, which speeds up combine harvesting and reduces harvesting losses.

Varieties of winter wheat.—Wheat variety tests were conducted in cooperation with the Pennyryle Grain Improvement Association in Todd county, in Daviess county, and on the Experiment Station farm at Lexington. Stem rust and Hessian fly were not present in damaging amounts at any location, but leaf rust was heavy in Todd county. The variety Redhart was severely damaged by winterkilling both at Lexington and on the Pennyryle field. Of the 6 varieties grown for the past 4 years in Todd county, Vigo has the best average yield, closely followed by Fulcaster, Clarkan, and Redhart. Currells and Thorne were definitely lower yielding.

Varieties tested for shorter periods having good yields are Royal, Purcam, and TN 1016-4. Of these, only Purcam is resistant to leaf rust. New strains of Frondosa x Trumbull-Hope-Hussar, resistant to both rusts, have been tested in nurseries at two locations and show considerable promise, though they are not resistant to Hessian fly.

Vigo has the best yield record of the commercial varieties for the past 4 years at Lexington, but is exceeded by several of the experimental rust-resistant strains for shorter periods. Vigo is susceptible to stem rust, but has moderate resistance to leaf rust.

Varieties of winter barley.—Winterkilling damaged the more tender varieties both at Lexington and at the Pennyryle field in Todd county, while the hardier varieties were not affected to any extent. Some of the less hardy varieties such as Davidson and Jackson 1 had considerable foliage killed, but the plants recovered to a full stand.

Jackson 1, a smooth-bearded variety of some promise in southern Kentucky, apparently was damaged in the Todd county plots, yielding 8.5 bushels per acre less than Ky 1. However, Jackson 1 still has a small advantage in average yield for the past three years at that location.

The hooded variety, Missouri Early Beardless, which is grown to some extent in western Kentucky, has been compared with Ky 1 in two locations for several years. In Todd county, it has averaged 10.8 bushels per acre less than Ky 1 for the past 4 years, and at Lexington 15.9 bushels less than Ky 1 for the past 5 years. In addition to its low yield, Missouri Early Beardless shatters badly and has an extremely weak straw. The only advantages of this variety are the absence of beards, its resistance to loose smut, and the fact that it matures about 5 or 6 days ahead of Ky 1.

Several experimental strains as early as Missouri Early Beardless, with stronger straw, higher yield, and some resistance to mildew and loose smut are now being increased for possible distribution.

Varieties of fall-sown oats.—All varieties suffered some foliage killing from cold weather at Lexington, and the very tender varieties were almost completely killed. Less hardy varieties such as Fulgrain and Victorgrain were damaged on the Pennyryle field in Todd county, and the yields were comparatively lower than in years when cold damage was negligible. These varieties have outyielded the hardier varieties when not winterkilled, but this year yielded considerably less than the recommended varieties Fulwin and Forkedeer.

Several newly-named varieties of Lee-Victoria x Fulwin parentage which show promise of combining strong straw, winterhardiness, and resistance to crown rust were tested in field plots in Todd county for the first time this year. These varieties, Arlington, Mustang, and Atlantic, were the three highest yielding of 10 varieties tested in plots at that location. Mustang, Atlantic, and a sister selection named Coy, survived the winter as well as the hardy varieties this year at Lexington, but Arlington was damaged somewhat more by cold weather.

Varieties of spring oats.—Yield tests of spring oats were conducted on the Experiment Station farm at Lexington. The season was very unfavorable for spring oats, and 37 varieties in the test averaged only 35 bushels per acre.

The recommended variety, Columbia, continues to be one of the high-yielding spring oat varieties. A selection of Columbia x Bond-Loggold, recently released by the Missouri station, and named Missouri 0-200, shows promise under Kentucky conditions. It is similar to Columbia in maturity and height, is resistant to the rusts, smuts, and *Helminthosporium* blight, and has a somewhat stronger straw than Columbia. Two other early maturing, disease-resistant varieties, Mindo and Andrew, have yielded as well as Columbia and have shorter, stiffer straw than either Columbia or Missouri 0-200. Clinton, one of the strongest-strawed varieties of spring oats, matures about a week later than the above varieties and has not yielded as much in Kentucky tests during the past 4 to 6 years.

Effect of lime in retarding availability of phosphorus in rock phosphate.—Four crops of red clover were grown in greenhouse jars

on Tilsit silt loam soil limed to varying degrees, in terms of percentage base saturation, and treated with rock phosphate at a rate to supply 250 ppm of P_2O_5 . These crops were grown and analyzed to determine the effect of liming on the availability to crops of phosphorus in rock phosphate. It was found that yields were increased greatly by rock phosphate applications to this soil until the calcium saturation reached 70 percent. Above 70 percent they fell rapidly until the degree of saturation reached about 100 percent, above which they remained quite constant up to 300 percent of saturation and averaged only 15 to 20 percent increase over the check jars.

Phosphorus content of clover in the same jars in both cuttings fell to a low value at about 90 percent of saturation (pH about 6.0) then increased again somewhat as calcium saturation went up to about 300 percent. The phosphorus content of clover in unphosphated jars ranged from .075 percent in unlimed soil to .165 percent in soil limed to 300 percent of saturation.

When the lime and phosphorus were applied in different layers in the jar, the phosphorus content of the herbage was fully as high and growth was as good as or better than in those jars where rock phosphate was used above or with lime mixed with all the soil at a rate to give 70 percent saturation.

Effect of time of application of nitrogen to green-manure crops on yield and value of burley tobacco under continuous cultivation.—As an average of one treatment in 1946 and duplicate treatments in 1947 and 1948, the application of 100 pounds of nitrogen per acre to a barley-vetch green-manure crop in March produced practically the same per-acre yields and values as when the same amount of nitrogen was applied at plowing time: 1,802 and 1,801 pounds, and \$879 and \$890, respectively. Fifty pounds of nitrogen applied to a barley-vetch green-manure crop gave a slightly lower yield but a larger per-acre income (1,778 pounds, \$901) than the application of 100 pounds of nitrogen.

Barley-vetch green-manure crops, as compared to barley green-manure crop without additional nitrogen, increased the yield and value of burley approximately 275 pounds and \$130 per acre. Addition of 50 pounds of nitrogen to the barley-vetch green-manure crop, as compared to a barley only green-manure crop with the same amount of nitrogen, increased the yield and value by 248 pounds and \$153 per acre. Larger amounts of nitrogen with barley-vetch decreased yields. On soils of low to medium content of available nitrogen, vetch has furnished enough additional nitrogen to produce about 250 pounds of burley tobacco per acre. Heavier applications of nitrogen with vetch have not been profitable.

Application of 100 pounds of nitrogen per acre at plowing in May to a barley green-manure crop returned \$100 more per acre than an equal amount of nitrogen applied in March and \$208 per acre more than 50 pounds of nitrogen applied at plowing. In these tests the highest average per acre return was for the barley green-manure crop with 100 pounds of nitrogen applied at plowing, \$956; second highest return was from a barley-vetch green-manure crop with 50 pounds of nitrogen, \$901. Barley and vetch without additional nitrogen (1,513

lb, \$720) gave similar yields to barley alone with 50 pounds of nitrogen (1,530 lb, \$748). Effectiveness of added nitrogen depended on the green-manure crop used. In the first two years of the experiment, time of application of the nitrogen made considerable difference in yield. An additional year's data largely eliminated this difference where heavy applications of nitrogen were made to barley-vetch green-manure crops. Where barley alone was used as the green-manure crop there was still a marked difference in favor of application when the barley was plowed under. All plots received uniform applications of potash.

Response of corn to triple superphosphate on Tilsit silt loam.—Response of corn to triple superphosphate was obtained in phosphate tests on Tilsit silt loam, a low-phosphate soil, in Warren county and in Christian county. Commercial fertilizers had not previously been used on the areas selected for these tests. All plots received an application of 30 pounds of nitrogen and 40 pounds of K_2O per acre at the row when the corn was planted, and an additional 30 pounds of nitrogen at the hill when the corn was knee high. The four unphosphated plots in the Christian county test produced an average of 7.7 bushels of ear corn per acre, compared to 42.9 bushels produced on plots where triple superphosphate was applied at the row at a rate to supply 30 pounds of P_2O_5 per acre. In the Warren county experiment three unphosphated plots averaged 10.2 bushels, while the plots treated with triple superphosphate produced 42.0 bushels of ear corn per acre. In both of these tests, an increase of more than one bushel of corn per acre was obtained for each pound of P_2O_5 applied.

Effect of raw rock phosphate and superphosphate on yield of corn on Tilsit silt loam.—In the spring of 1949 an experiment comparing phosphates was started on Tilsit silt loam at Greenville. Corn was grown this year. The nitrogen, phosphate, and potash applications were broadcast and disked in before the corn was planted. All plots were limed at the rate of 2 tons per acre and received 60 pounds of nitrogen and 60 pounds of K_2O . Each treatment was replicated three times. The unphosphated plots produced 22.4 bushels of corn per acre. Plots where rock phosphate was broadcast at rates to supply 60 to 120 pounds of P_2O_5 per acre produced yields of 25.1 and 28.9 bushels respectively, while yields of 46.7 and 59.1 bushels per acre were obtained where the applications were 30 and 60 pounds of P_2O_5 respectively in triple superphosphate. The application of 100 pounds of P_2O_5 in rock phosphate and 20 pounds in triple superphosphate produced 41.5 bushels of corn per acre. (Corn is not a strong feeder on rock phosphate; yield increases for rock phosphate probably will be more favorable after legumes are grown in the rotation.)

Crop response to different rates of phosphate application.—Effect of different rates of phosphate applications on crop yields is being studied on Tilsit silt loam at Greenville. Each plot received 80 pounds of nitrogen and 160 pounds of K_2O per acre each round of the rotation. Triple superphosphate was applied at rates to supply 40, 80, 160, 240, and 320 pounds of P_2O_5 per acre each round of rotation. A rotation of corn, wheat, and red clover hay is being grown on the plots. Yields were as follows:

Pounds P_2O_5 Applied	Acre-Yields of —		
	Corn, average 3 crops bu	Wheat, average 4 crops bu	Red clover, average 3 crops lb
40	47.0	16.3	3695
80	57.8	22.6	4870
160	65.8	25.4	6186
240	71.3	27.6	5955
320	68.8	27.3	6361

Available potassium in bluegrass soils.— The replaceable potassium content of samples of soil at various depths from plots receiving more or less potassium fertilizers in a tobacco rotation was determined. Samples of tobacco leaf were taken from the same plots to find out whether there was any good agreement.

In untreated soil the replaceable potassium content was quite constant in each layer down to 18 inches in depth. Where no potassium was added but nitrogen was used, replaceable potassium was lower in the surface than in the untreated soil. As potassium fertilizers were applied in addition to nitrogen, the amount of replaceable potassium did not increase markedly until the applications reached 150 pounds per acre of potash per rotation. Up to that point the added potassium seemed to be used by tobacco crops in increased yield and percentage composition.

A good correlation was found between the replaceable potassium content in the soil and the potassium content of the plant.

Crop response to applications of minor nutrients.— During the past two years, tests have been conducted to measure the response of corn and tobacco to application of minor nutrients. Zinc sulfate, copper sulfate, manganese sulfate, and ferric sulfate were applied each at the rate of 10 pounds per acre, borax 5 pounds per acre, and magnesium sulfate 25 pounds per acre. These materials were applied as a mixture 3 to 4 inches below the surface of the soil along the row after the crop had started growing. The experiments were on soils of different fertility levels in 12 counties.

In 1948 the average corn yield for three experiments was 50.6 bushels on the treated plots as compared with 50.3 bushels on the untreated plots. In 1949 the treated plots averaged 68.1 bushels and the untreated plots 66.6 bushels. Tobacco was used as a test crop in six different experiments in 1948. The average yield from the treated plots was 2,376 pounds per acre and from the untreated plots 2,389 pounds. In two of the six tests, the quality of the tobacco from the plots treated with minor nutrients was slightly better but the difference was not significant.

Minor elements in limestone and marl.— Spectrographic analysis of chemical composition of limestone and marl was undertaken to reveal the cause of beneficial effects of these materials in stimulating increased crop growth in pure sand culture experiments. The effects noted were proved to be other than those accruing from the presence of calcium and magnesium carbonates. The presence of several minor elements in amounts sufficient to induce luxuriant crop growth was demonstrated. These minor elements included magnesium, iron, cobalt, copper, manganese, molybdenum, nickel, and zinc in addition to phosphorus and calcium and other major elements.

The amounts of these elements present varied from mere traces to more than 1 percent, depending upon the element and the origin of the sample. Thus, from a practical standpoint, a normal application of 3 tons per acre of ground limestone includes minor-element materials up to 60 pounds per acre and, if liming is carried out as recommended, sufficient minor elements are added to take care of normal crop needs. Further evidence for this is obtained from spectrographic analysis of Kentucky soils and separated colloidal particles removed from these soils. The presence of sufficient minor elements is demonstrated in soils examined to date. It has been estimated that from 65 to 80 percent of the soils of Kentucky were formed from limestone or other calcareous material and since the minor element carbonates are among the most insoluble (unavailable) compounds known, it is not too surprising that those soils contain considerable amounts of most minor elements and do not respond to field applications of them. It would therefore seem probable that noncalcareous soils of the state of Kentucky might prove more responsive to minor-elements fertilization.

Availability, function, and metabolism of minor elements in Kentucky soils and plants.—It has been shown spectographically that cobalt, copper, magnesium, manganese, iron, molybdenum, nickel, and zinc are all existing in different degrees of solubility in Kentucky soils, as measured by extracting solutions of increasing strength and in different-sized soil particles ranging from unseparated soils to 1-micron clays extracted from these soils. The function and metabolism of the minor elements have much more than a mere agronomic importance and are receiving special attention. Progress is hampered by the necessity of developing adequate spectrographic methods of analysis of plant materials.

Field experiments with replicated plots receiving minor elements at three fertility levels have failed to yield increased growth or better quality of barley. Applications of 100 pounds per acre of each minor element except boron have failed to affect the yield, though the heaviest application of boron caused some burning in the fall.

Efforts to develop a quick soil test for boron have not been successful because traces of nitrate and fluorine in soil extracts could not be removed. A study of the metabolism of boron in respect to calcium absorption and protein synthesis is being undertaken to clarify the function of boron in plant growth.

Results of the field applications of minor elements would indicate that spraying with compounds such as calcium arsenate and copper sulfate (bordeaux mixture) for control of insects and disease in certain crops, is not detrimental to the land for further cropping.

Soil iodine resistance to leaching with water.—In iodine analyses on a number of soils from Wisconsin, Michigan, Minnesota, Oregon, and the Experiment Station farm at Lexington the iodine content was found to be highest in peats and clays, intermediate in loams, and lowest in the sands. Extraction experiments on all these soils indicate that iodine is very resistant to leaching with water. Only 3 to 10 percent of the total iodine could be extracted with distilled

water in a period of 24 hours. Preliminary data suggest that this fixed iodine is not in a simple adsorption complex.

Sweet corn varieties.—Sixty-one varieties of corn were tried. Narrowgrain hybrid gave by far the largest yields in the early trials and was fourth in the late trials. Evergreen hybrid was second in both the early trials and the late trials. Gulf Coast and Huron, from the Vegetable Breeding Laboratory at Charleston, South Carolina, yielded well in the trials. Golden Grain, also a high yielder, produced well in previous tests and has high quality.

Effect of heavy applications of fertilizer on yields of lima beans.—Bush limas (Fordhook 242) were grown with large additions of fertilizer. The soil used was high in phosphorus and medium in nitrogen and potash. One ton of 20-percent superphosphate per acre alone gave an increase in yield of 19 percent, while 2 tons alone did not give a further increase in yield. When 2 tons were used with 600 lb of ammonium nitrate, a 30-percent increase was obtained. When 300 lb of muriate of potash were added to 2 tons of superphosphate and 600 lb ammonium nitrate, a 23-percent increase was obtained. This shows that potassium was not needed to increase yields of the limas. Where both nitrogen and phosphorus were used 260 bu per acre were obtained, while the checks produced 206 bu per acre.

Lima bean varieties.—Eleven lima bean varieties were tested. An Oklahoma variety, designated as 8-2, was outstanding in high yields. It is a small processing-type bean. Clark's Bush was second in yield.

Snap bean varieties.—Twenty-four varieties of snap beans were tested. Of these, a variety of the Vegetable Breeding Laboratory at Charleston, South Carolina, was high, with 427 bu per acre. This variety is designated as B2254 and is not yet available in seed markets. Rival, a variety now on the market, was second with a yield of 398 bu.

Elevated Logan, which holds its crop off the ground, was a good producer, yielding 368 bu per acre. Ordinary Logan, whose crop tends to touch the ground, yielded 366.4 bu per acre.

Pole bean varieties.—Several new pole bean varieties were tested, but none equaled Kentucky Wonder in yields or quality.

Methoxychlor spray on beans.—Methoxychlor spray was again tried on snap, pole, and lima beans. Two sprayings or dustings gave almost complete control of bean beetle and kept the vines in excellent condition. The spray consisted of 2 pounds methoxychlor in 100 gallons of water. The dust was made up of 15 pounds of methoxychlor and 85 pounds of talc applied at the rate of about 30 pounds of the dust mixture per acre. One-half acre of lima beans sprayed twice had the healthiest vines and produced the best lima bean crop on record at the station.

Cucumber insects.—Preliminary work on the control of insect pests affecting cucurbits indicated that the striped cucumber beetle, *Diabrotica vittata* (F.), and the striped flea beetle, *Phyllotreta vittata* (F.) can be effectively controlled on cucumbers. In tests in which cucumbers were grown and dusted with methoxychlor, purified DDT, odorless benzene hexachloride, parathion, and calcium arsenate, the

harvest yields of plots dusted with 3-percent purified DDT or 5-percent methoxychlor were significantly higher (47 and 59 percent respectively) than yields from check plots dusted with calcium arsenate—gypsum (1-9). Dust applications were made at 7-10 day intervals until a week before the first picking.

Tomato varieties.— Fifty-five varieties were tested. When total yield alone was considered, a numbered variety (57) from the Vegetable Breeding Laboratory at Charleston, South Carolina, was first. This variety gave a 20-ton per acre yield and had a high percent salable. However, it was a little small in size and was a late type.

When total yield, early yield, size, and percent salable were all considered, Stokesescross No. 5 was highest in average rank, giving a total yield of 17 tons per acre. It had the highest early yield, higher even than Valiant. The percent salable of the early yield of this variety was especially noteworthy, the fruits being of good size. Garden State ranked second in earliness and size of fruit. VPI No. 12 was especially large and of good quality and produced large yields, being fourth in average rank.

Hormone treatment of tomatoes.— Plots of tomatoes in the greenhouse treated with varying amounts of nitrogen and phosphorus fertilizers were divided into subplots and treated with four kinds of hormones. The hormones caused significant increases in early yields, in some cases giving almost a 50-percent increase. The effects on total yields were not so pronounced.

The hormone-nitrogen interaction was statistically significant. Effects of the fertilizer on early yields were accentuated by the hormones so that much larger increases were obtained. When all nitrogen and no phosphorus was applied, the early yields were depressed on the plots not treated with hormones, but the use of hormones tended to overcome this depressing effect of too large amounts of nitrogen.

A field planting of twenty 80-ft rows of early tomatoes with five replications was treated with hormones during early May to note the effect on early and total yields. No significant differences were obtained in total yields, but in early yield naphthoacetic acid gave a small increase in one case and a 30-percent increase in another. Another new hormone gave no significant increase. Since the season was quite favorable in May, no large increases were expected.

Bands for tomato plants, impregnated with plant food.— To avoid the serious objection of using ordinary plant bands to replace expensive clay pots, that the cellulose in the bands tended to lock up plant food, especially nitrogen, a band has come out which has plant food impregnated in the walls. One band had enough for 10 weeks, and another enough for 40 weeks. These were tried on tomato plants. The 10 weeks' supply was enough to make exceptionally strong, vigorous plants. Tissue tests showed plants in ordinary bands to contain as low as 100 ppm of nitrogen while those in the bands impregnated with plant food contained over 1,000 ppm of nitrogen.

Production of tomato seedlings in vermiculite.— Tests were made of the lightweight mica-like mineral called vermiculite as a material in which to produce tomato seedlings. The seedlings came

up with the seed coat on the cotyledons and had difficulty shedding them. Seed planted in half soil, half leaf mold, came much faster and better. Seedlings transplanted into vermiculite and watered with a nutrient solution grew better than those in leaf mold soil, and when the plants were taken out the entire root system came out of the vermiculite with remarkable ease and very little injury. These plants started off better than plants from leaf-mold soil. However, the mixing of soil and vermiculite seemed to favor the occurrence of damping-off organisms in several trials.

Allyl alcohol versus methyl bromide for plant beds.—Allyl alcohol and methyl bromide were compared as herbicides in plant beds, as they are believed to be the only herbicides found so far that can be applied to a soil to kill weed seed and get out quickly so vegetable seeds can be planted.

On the section treated with 2 cc of allyl alcohol in 1 pint of water per square foot there later grew 0.21 of a weed per square inch. Where 1 lb of methyl bromide was used per 100 square feet there was 0.36 of a weed per square inch. The allyl alcohol was sprinkled on from a sprinkling can. No cover was needed for the allyl alcohol, but a gas-proof paper cover was used on the methyl bromide. The results were in favor of allyl alcohol. On the untreated check there were 2.06 weeds per square inch. Furthermore, hard-seeded plants such as morning glory and three-seeded Mercury came up as much as six to one in the methyl bromide plot more than in the allyl alcohol plot.

Use of a cellulose acetate film cover instead of the paper cover increased the effectiveness of methyl bromide, the count where the film was used being only 0.024 weeds per square inch. This probably was due to the high temperature under the film caused by penetration by sunlight. Under this film 0.5 pound of methyl bromide per 100 square feet was as effective as 1 pound per 100 square feet.

Copper-oxide spray for blight on tomatoes.—Previous tests have shown fixed copper (45-percent copper) to be one of the best sprays to keep blight off of tomatoes, especially septoria and late blight, and to be fairly efficient also for early blight. A new copper oxide spray which carries 90 percent copper is a much cheaper buy and is being advocated as a substitute for fixed copper. It was tried on both an early and a late planting of tomatoes. As May and June were dry, little blight of any kind occurred and the test was of no value, but on the late crop, considerable late blight and septoria was present. Late blight causes an easily detected rot on the fruits. On the plots sprayed with 45-percent fixed copper 170 rots occurred, and on the copper oxide plots there were 194 rots. The unsprayed plots had over three times as many rotted fruits as the sprayed plots. The cheap spray thus was about as effective as the usual fixed copper. It warrants further trial.

Potato varieties.—In replicated plots of potato varieties the following results from early plantings were obtained, the replicates being very consistent:

Variety	Bushels	Percent salable	Texture
Sequoia	495.4	58.5	smooth
Placid	407.4	47.9	rough
Chenango	350.7	55.9	smooth
Snowdrift	276.8	55.5	very smooth
Fillmore	134.4	64.3	rough
Virgil	117.8	63.3	rough
Essex	123.2	68.8	medium
Empire	115.2	64.3	rough

In a late test Sequoia yielded 350 bushels per acre, with 90 percent salable tubers, while Irish Cobbler yielded 212 bushels per acre under the same conditions, and also had 90 percent salable tubers.

Black raspberry varieties.— In a planting of Morrison and Quillen black raspberries, the yields of 24-pint crates per acre for the past three years have been: Morrison, 354, 153, and 293 crates; and Quillen, 367, 96, and 121 crates. Morrison is higher in quality and more attractive, and Quillen is slightly less susceptible to anthracnose.

Mulching red raspberries.— In the third season after planting Latham red raspberries under treatments of cultivation versus mulching, the yields of 24-pint crates were at the rate of 193 per acre with mulch, and 135 per acre with cultivation. The mulched plants were much more vigorous and showed less disease than those under cultivation.

Strawberry varieties.— In a variety test of Tennessee Beauty, Tennessee Shipper, Blakemore, Premier, and Aroma strawberries in cooperation with 10 commercial strawberry growers, Tennessee Beauty was given highest rating in yield, size of berry, quality, resistance to fruit rots, and as an all-around berry. There was a three-way tie in firmness rating among Tennessee Beauty, Tennessee Shipper, and Blakemore though Tennessee Shipper usually rates slightly firmer than the other two. In plant making ability, Blakemore rated first, Tennessee Beauty second, and Tennessee Shipper third, and in ability to come through drouthy, adverse summers, the rating was the same. Neither Premier or Aroma was rated up with the other three.

Strawberry weevil.— Work on the control of the strawberry weevil, *Anthonomus signatus* Say, was extended to include tests in several cooperating farms in the western and southwestern parts of the state. Chlordane dust (5 percent) gave outstanding results in 1948 and again in 1949. As an average of tests in different localities, plots treated with chlordane averaged 6.1 percent buds cut as compared to 35.4 percent buds cut in the untreated plots. Treatment with a mixture of 5-percent chlordane and 5-percent DDT dust averaged 7.4 buds cut, and treatment with 20-percent toxaphene dust averaged 8.9 buds cut. Treatments with 5-percent DDT dust or 1.5-percent gamma isomer benzene hexachloride dust resulted in 12.4 and 12.2 buds cut, respectively.

Millipedes on strawberries.— Western Kentucky strawberry growers suffered heavy early losses from millipedes feeding on the ripening berries. At Sharpe almost a third of the berries (32.7 percent) were injured where no insecticides were applied. Best control was obtained with 2 applications of 20-percent toxaphene dust (2.8

percent injury), while 5-percent chlordane dust was second best (6.1 percent injury). The other insecticides tested, 5-percent chlordane and 5-percent DDT dust in combination, and 1.5 percent gamma isomer benzene hexachloride, allowed 12.6 and 8.0 percent injury respectively.

Strawberry crown borer.—Laboratory tests were conducted in early April to determine the performance of parathion, benzene hexachloride, toxaphene, chlordane, compound 118, and DDT against large numbers of strawberry crown borer beetles, *Tylocoderma fragariae* (Riley), collected overwintering in an old berry patch. Beetles were placed at the base of caged potted strawberry plants and treated. Of the materials tested, 1- and 2-percent parathion dust, 5-percent chlordane dust, and 20-percent toxaphene dust gave excellent control. Poor results were obtained with 1.5- and 3-percent gamma isomer benzene hexachloride and 5-percent DDT dusts. Fair results were obtained with 2.5-percent 118 dust and DDT (2 pounds 50-percent per 100 gallons) spray. On April 20 a field experiment was conducted in Jefferson county on a newly set strawberry patch which was being invaded by crown borer adults from adjacent old patches. Two plots, each 140 feet long and 4 rows wide were treated, one with 5-percent chlordane dust and one with 20-percent toxaphene dust, using a knapsack continuous duster. The rest of the patch was left untreated. Five days later 98 percent of the beetles were either dead or dying in the treated plots, while in the untreated area large numbers of live beetles were present.

Peach pruning.—In the cooperative peach pruning tests at Henderson, 12-year-old peach trees pruned by the modified-leader system and by the open center-system produced an average of 10 bushels of peaches each, while the unpruned trees averaged 12 bushels each. One tree pruned for the first time in 1948, its eleventh year, was pruned again in the spring of 1949 and produced 14.8 bushels this season, now being one of the finest, most vigorous trees in the orchard. Another unpruned tree which had been seriously broken down by its heavy crops in 1947 and 1948 was given a corrective pruning in the spring of 1949 and produced 5.5 bushels of fruit. This tree made excellent growth and recovery in 1949.

The pruning work to date indicates that pruning can be left off as long as 10 to 12 years, and that proper pruning can then restore the tree to a sound, manageable peach-producing unit.

Peach harvest survey of insect and disease damage.—In a harvest survey of 16 peach orchards in western Kentucky, the outstanding fact was injury in 12 of the 16 orchards from the red banded leaf roller, a new orchard pest in Kentucky. Injury from this pest varied from 0.3 to 44 percent and averaged 6.7 percent of the fruit. The leaf roller had invaded the peach orchards following extended use of DDT and other organic, non-arsenical insecticides. This pest, being equally at home on apples, peaches, and many shade trees and ornamental plants, poses a real problem for Kentucky and midwest fruit growers. In 1949, peach orchards that were sprayed or dusted with lead arsenate or parathion had less leaf roller troubles than others. Rothane is specific against this pest and is adapted for use on either apples or peaches.

In one of the 12 orchards parathion was used through the season, giving excellent control of curculio, oriental fruit moth, leaf roller, mites, and summer scale. In 5 other orchards surveyed, some parathion was used in the second-brood applications, either as sprays or dusts. Because of these split schedules, it was impossible to determine the exact amount of control due to parathion, but all 5 orchards had exceptional curculio control and better-than-average control of oriental fruit moth and leaf roller.

Curculio control was, in general, good. Cases of poor control could be ascribed to poor timing, poor application, and a questionable selection of materials. In orchards with light infestation, the lead arsenate sprays gave good control and was the most practical schedule. In heavy infestations, lead arsenate sprays were not effective. There were also indications that benzene hexachloride did not perform as well in 1949 as it had earlier. More early season chlordane is indicated in the Kentucky peach spray schedule.

Bacterium pruni spotting to fruit was again worse in orchards where non-arsenical spray programs were used. Two orchards that had used the standard schedules of lead arsenate, zinc sulfate, and lime in the past, changed to a benzene hexachloride and chlordane schedule in 1949, and for the first time had 12 and 21 percent *pruni* spotting of the fruit.

Hardy apple stocks.—Hibernal crab and Virginia crab are being compared as hardy stocks upon which to top-work apple varieties. After 2 years' growth, the following have made greater growth on Hibernal than on Virginia crab: Wealthy, Grimes, Polly Eades, and Golden Delicious. Paducah is showing much stronger growth on Virginia crab.

New apple varieties.—Several new apple varieties under test in the Experiment Station orchard appear promising and worthy of mention. Varieties developed by the New York Fruit Testing Association that were outstanding this past season were Melba, Webster, Joan, and Lobo. Those developed by the Minnesota Station that appear promising were Minjon, Fireside, Prairie Spy, Redwell, Beacon, and Haralson.

The Minjon apples were the most attractive fruits grown in the Station orchard this season. The trees were only 4 and 5 years old, and yet the older of these produced over 3 bushels and the young one nearly 2. The trees have grown excellently; fruits were harvested September 2. The exact parentage of this variety is not known because the record of the cross was lost, but it is thought to be a cross between Jonathan and Wealthy. The fruits average about the size of Jonathan and develop a deep, attractive, solid red color. Minjon is rated by the Minnesota Station as one of the outstanding kinds which they have introduced. Our experience this year indicates that the fruits of this variety should be used in October, because there is a considerable loss of quality if they are kept in storage until even early December. The apples average about the size of Jonathan.

Tissue firming in frozen berries and vegetables.—Since calcium salts effect a firming of tissues in canned products, an investigation was

undertaken to find out if similar results would be obtained in frozen foods. Strawberries, raspberries, spinach, and asparagus were chosen for testing, and were prepared and frozen by accepted methods, calcium chloride and calcium gluconate being added in 0.09 and 0.18 percent amounts, respectively. After 6 to 7½ months in the freezer locker they were taken out for testing. Tissue firmness was measured by drained weight. Ascorbic acid was determined in order to note changes, if any, in vitamin content, assuming that if very little change took place in vitamin C content the other more stable vitamins would not be greatly affected. A panel of tasters judged palatability in order to evaluate consumer acceptability.

Drained weights of berries were greater in those treated with calcium salts, indicating firmer tissues. There were slight differences between the effect of chlorides and gluconates, but not so consistently that either could be recommended above the other. A definite correlation was noted between the drained weight and the judgment of the tasters on texture. Flavor was less affected by the gluconates than by the chlorides, although neither calcium chloride nor calcium gluconate in 0.09-percent concentration was even slightly unpleasant. On the contrary the average judgment was that an enhancement of flavor was produced. Calcium gluconate was less noticeably salty than calcium chloride.

The calcium salts tended to lessen the destruction of ascorbic acid in the raspberries and in the Tennessee Shipper strawberries but not to any appreciable extent in the Blakemore strawberries.

Also, the calcium salts tended to protect the ascorbic acid in asparagus, but gave very little protection in spinach with the exception of 0.18 percent calcium gluconate, with which the ascorbic acid loss was less than in any of the other lots of frozen spinach.

According to the judgment of the taste panel the texture of the asparagus was not improved by calcium salts. The texture of the spinach was not affected appreciably except in the lot to which had been added 0.18 percent calcium chloride where a definitely better texture was noted than in the other lots. There seemed to be no consistent correlation between drained weight and texture nor did the calcium salts seem to have a consistent effect on the drained weights of either spinach or asparagus.

In general the calcium salts had a desirable effect on frozen berries, but little value for frozen spinach or asparagus.

Effect of riboflavin and choline on fat transport.—Effective fat transport through the liver is essential to good health and it is believed that poor transport is of rather common occurrence, especially among people past middle age. Methyl groups attached to nitrogen, such as are found in choline and methionine, seem to be essential for the transport. Because of the high content of riboflavin in the liver, it may be, that, acting as a co-enzyme, or in some other capacity, it may facilitate or possibly in a slight degree take the place of the methylated nitrogen. In order to test the possibility, rats are being fed diets high in fat and containing two different levels of choline, with four variations in riboflavin content. As the animals become moribund analyses are made of blood riboflavin. The iodo-acetate test for tumors is made on blood serum. Upon death of the animals the carcass is thoroughly

examined for abnormalities. The liver and all abnormal growths are sectioned and examined histologically. Riboflavin is determined on the liver and kidney.

The experiment must be carried on until the animals are past middle age. Gain in weight, up to the point of marked obesity, is expected on the three high-fat diets. So far, obesity is decidedly greater in the rats getting 0.81 mg percent of riboflavin than in those getting less riboflavin, whether the choline intake is 10 or 20 mg per day.

Maintaining summer milk production.—Feeding either corn silage or an extra amount of grain mixture to milk cows on pasture from August 1 to September 11 aided in preventing the midsummer decline in milk production. Benefits, however, were probably not large enough to be economically profitable. Because of abundant rainfall during the experimental period, grazing was better than average.

Three groups of two Jersey and two Holstein milk cows were on pasture consisting largely of orchard grass with a light stand of ladino clover. From July 18 to July 31 all groups received a 16-percent grain mixture at the rate of 0.6 lb for each 1 lb milk in excess of 10 lb daily for Jerseys and 0.4 lb for each 1 lb milk in excess of 15 lb for Holsteins. Beginning August 1, group 1 was continued on the same grain ration, group 2 was given the same grain ration plus all the corn silage the cows would clean up, and group 3 was given the same grain ration plus extra amounts of the grain mixture as a supplement. The average daily consumption of silage by group 2 was 15.4 lb per cow and this contributed 18 percent of the calculated total digestible nutrients (TDN) required by the cows.

The extra amounts of grain mixture consumed by group 3 amounted to 2.7 lb per cow daily, which in terms of TDN was 17.3 percent of their calculated requirements.

In terms of 4-percent-fat-corrected milk, the daily milk production per cow for the 42-day experimental period, when compared with that for the 14-day preliminary period, declined 2.73 lb for cows receiving the check ration, declined 1.25 lb for those receiving the silage as supplement, and increased 1.12 lb for those receiving the extra allowance of the grain mixture.

In body weight the cows in the check group gained an average of 36 lb per cow during the experimental period, those receiving silage gained 70 lb per cow, and those receiving extra grain gained 82 lb per cow.

Grazing time of milk cows in warm weather.—Observations were made of 12 milk cows on pasture during two relatively warm days, August 25 and 26. Time spent grazing averaged 3 hours and 57 minutes during the day (between a.m. and p.m. milkings), and 3 hours and 40 minutes at night (between p.m. and a.m. milkings). While not grazing during the day 8 of the cows averaged 2 hours and 27 minutes standing in the shade, 2 hours and 8 minutes lying in the shade, and 13 minutes in the sun but not grazing. The cows when not grazing during the night, averaged lying down 7 hours and 3 minutes and remained standing but not grazing for 12 minutes.

Four cows were allowed access either to shade without a sprinkler or to shade equipped with a mist-like sprinkler. Three of these cows

(2 Holsteins and 1 Jersey) made use of the sprinkler an average of 1 hour and 30 minutes daily. Grazing during the day for this group averaged 4 hours and 20 minutes, or slightly more than for the remaining cows. Significantly lower respiration rates and slightly lower body temperatures were observed at 3:00 p.m. for cows having access to the sprinkler. This difference, however, was not reflected in a detectable improvement in persistency of milk production during a 42-day experimental period.

Factors affecting the chemical composition and physico-chemical properties of milk.—Samples of milk from individual cows were obtained for this study from six Holsteins and six Jerseys over a period of a year. The samples were taken and analyzed bimonthly for freezing point, specific gravity, titratable acidity, pH, percent fat, percent lactose, percent protein, percent ash, and protein stability. On the average, the Holstein milk had a slightly higher freezing point, pH, and lactose content. There was very little relationship between season of the year and the analytical values obtained. With the exception of protein content, the various constituents did not change significantly from the beginning to the end of the lactation period. The amount of protein in the milk increased through the first eight months of the lactation period. Freezing points were significantly higher than the value now accepted as standard for milk unadulterated with water.

Breeding data from artificial insemination records.—Of 19,665 cows and 1,265 heifers, the heifers averaged 2.3 percent more return services than the cows. To see if age of heifers had any important influence on breeding efficiency, age-groups were set at 3-month intervals and extended from 12 months to 24 months or over. There was no significant difference between the four age-groups for 337 Holsteins or 190 Guernseys. However, among 617 Jersey heifers there was a significant drop in efficiency as the heifers passed 15 months of age.

Freshening dates were available for 10,587 cows at the time of first service. Cows bred at 5 weeks or less after calving averaged nearly 20 percent more returns than cows which had been fresh 2-3 months.

Time that heat was noticed and time of breeding were recorded for 19,665 cows as "AM" or "PM." Any time of breeding proved satisfactory, through records did not extend more than 24 hours beyond the time when heat was noticed.

Of 5,304 cows which failed to conceive at first service, 4.8 percent returned for service in 1-17 days, 49.6 percent in 18-24 days, 11.4 percent in 25-36 days, 16.3 percent in 37-47 days, and 17.8 percent in 48 days or over.

Of 3,283 herds (average, 5.8 cows) about 28 percent had very good breeding efficiency (1.0 services per cow), 65 percent were average (1.1-2.0 services per cow), and 6.5 percent had poor breeding efficiency (2.1 or more services per cow).

Distillers' dried solubles in the ration of dairy calves.—Distillers' dried solubles as a replacement for dried skimmilk in a calf starter were tested in an experiment with three groups of four calves each. Group 1 received the basic calf starter containing 24.4 percent dried skimmilk. Distillers' dried corn solubles and rye solubles were substituted for the skimmilk in the starters which were fed to the

calves in groups 2 and 3. The dried solubles were from mashes which contained 72 percent corn and 52 percent rye, respectively.

The calves were taken from their dams at 48 hours of age, placed in individual pens and fed whole milk at the rate of 1 pound to 10 pounds body weight to 30 days of age. At 2 to 3 weeks of age the starters were offered to the calves and some rubbed on the calves' noses at feeding time to accustom them to the ration. The starter was offered free-choice to a maximum of 5 pounds per day. A good quality leafy alfalfa hay was fed *ad libitum*. In a 16-week test period the four calves in group 1 averaged 93.5 pounds total gain in weight while the average total gains in groups 2 and 3 were 113.5 and 84.3 pounds, respectively. Group 2 required 2.21 pounds of total digestible nutrients (calculated) for each pound of gain as compared to 2.54 and 2.52 pounds for groups 1 and 3, respectively. With the number of calves involved, these differences were not statistically significant.

Corn gluten meal versus soybean meal in animal protein factor studies in laying hens.—Six groups of 30 New Hampshire pullets in colony houses and six duplicate groups of 6 New Hampshire pullets in laying batteries were fed a corn gluten meal basal diet, a soybean meal basal diet, and each of these diets supplemented with 5 percent of whitefish meal, and 14 micrograms of vitamin B₁₂ per pound. In colony houses with deep litter there were no significant differences in percent production, egg size, or percent hatch of fertile eggs between the groups fed the soybean meal basal diet or this diet supplemented with vitamin B₁₂ or fish meal. The corn gluten meal basal diet did not support as high a rate of production, egg size, or hatchability as that maintained by the soybean meal basal diet. Supplementation of the corn gluten meal with fish meal significantly increased the rate of production, egg size, and percent hatch of fertile eggs. Supplementation with vitamin B₁₂ increased hatchability but did not improve production nor egg size.

Comparable results were obtained when the same rations were fed to pullets maintained in laying cages.

Fiber in chick starting rations.—Ground oats, alfalfa meal, and wheat bran alone and in various combinations were tested to show the influence on chick growth of fiber from various feedstuffs in starting rations. On an equivalent fiber basis, alfalfa meal and wheat bran had a greater depressing effect on growth than did ground oats. Growth obtained on various combinations of these feedstuffs exceeded that on a starting ration containing the same amount of fiber from a single feedstuff when the total fiber content of the ration was approximately 7 percent. Maximum growth was obtained on rations containing approximately 5 percent or less fiber from any source. Comparisons between experiments indicate great differences in the growth-promoting properties of different samples of alfalfa meal. These differences can probably be attributed to factors other than the fiber content.

Meat scrap and distillers' dried solubles versus soybean oilmeal and distillers' dried solubles for pullet growth.—Two broods of New Hampshire chicks were started on a complete ration. When the chicks were old enough to be allowed on pasture (about 6 weeks) one

brood was fed grain and a mixture of meat scrap and dried distillers' solubles (2 percent salt added) and one brood a mixture of soybean oilmeal and dried distillers' solubles (2 percent salt added) and steamed bonemeal. When the pullets were 5 months old, 100 were selected from each group, placed in the laying house and fed a laying mash, grain, and ground limestone. The average results were as follows:

<i>Protein Supplement in Growth Ration</i>	<i>Egg Production</i>	
	<i>To March 1</i>	<i>Total for Year</i>
Meat Scrap and Dried Solubles	121	229
Soybean Oilmeal and Dried Solubles	107	198

Green pasture was available at all times during the growing period.

Incidence of Newcastle disease of chickens.—A total of 96 laboratory examinations were made on material from chicks suspected of having Newcastle disease. Serum samples from 80 flocks were tested by the hemagglutination inhibition test. Of these, 28 showed reactions indicating that the chickens had experienced infection with Newcastle disease virus. Tissues from 16 flocks were inoculated into embryonated eggs for virus isolation. Newcastle disease virus was isolated from 5. Pooled tissues and serums from chicks in 2 flocks yielded positive results on both virus isolation and hemagglutination inhibition tests.

Newcastle disease virus in unembryonated eggs.—Before placing in the incubator, 2 groups of 54 eggs were injected in the yolk with 0.05 ml of inoculum carrying 1,000 and 10,000 LD₅₀ of Newcastle disease virus. When first candled on the 8th day of incubation, none of the eggs receiving 10,000 LD₅₀ had living embryos. The size of dead embryos indicated death had occurred between the 4th and 6th days. With the 1,000 LD₅₀ of virus, 48 eggs were infertile or contained dead embryos on the 8th day, and the remaining embryos were dead by the 16th day of incubation. Newcastle virus was recovered from 2 embryos dying on the 14th day. Two additional groups of 54 eggs each were injected in the albumin with doses of 1,000 and 10,000 LD₅₀ of Newcastle virus. With the 1,000 LD₅₀ dose 44 were dead or infertile at the 8th day of incubation. Two embryos were dead on the 9th, and 1 on the 15th day. The virus was isolated from these. Seven embryos were living at the 21st day. With 10,000 LD₅₀, 47 eggs were infertile or contained dead embryos on the 8th day. The virus was recovered from 1 embryo dying on the 15th day. Six embryos were living at 21 days.

Immune response of chicks with parental immunity to Newcastle disease.—A group of chicks hatched from eggs laid by hens 2 months following an outbreak of Newcastle disease were divided in 3 groups: (A) controls, (B) vaccinated intranasally at 3 days of age, and (C) vaccinated intramuscularly at 3 days of age with live virus vaccine. At 34 days of age the entire group was challenged by intratracheal administration of 0.1 ml of virulent Newcastle virus. In the control group, 31 percent of 22 chicks were lost from death or paralysis, and the remaining chicks suffered severe illness. The vaccinated chicks, 55 in both groups, showed no illness and had no death losses as a result of the challenge. Daily hemagglutination inhibition testing of

the chicks following exposure established a characteristic susceptible response curve for the controls. For the vaccinated birds, the response was typical of chicks having previous experience with Newcastle virus. Both the control and vaccinated groups had negative hemagglutination inhibition titers before they were challenged. Another group of 42 chicks from immune hens were vaccinated intranasally at 5 days of age. They were challenged at 35 days of age using the same virus on the same date as for the chicks described above. These chicks suffered no death losses or paralysis. Slight sneezing was observed in a few birds. It appears that an active immunity may be engendered in parentally immune chicks, but the degree and duration of the immunity has not been established.

Newcastle disease hemagglutination inhibition (HI) tests on egg yolk.—The presence of antibody against Newcastle disease virus in yolk of eggs laid by immune hens makes it possible to diagnose the disease in laying hens by laboratory tests on egg yolk. Eggs from 34 hens were used in comparative testing for HI titers of egg yolk and serum from individual birds. Tests were made on 266 eggs, an average of 7.82 per hen. Serum samples were obtained at the beginning and end of a 15-day period during which the eggs were collected. HI titers of the yolk from individual hens varied from 2- to 16-fold during the 15-day period. At the beginning of the experiment the serum titers averaged 1:230, and at the end 1:96. The average HI titer for the yolk was 1:159, while the mid-point for the serum titer averages was 1:163, indicating a close over-all agreement for the serum and yolk titers.

Newcastle disease hemagglutination inhibition (HI) titers of normal chicks.—Serum from 283 normal chicks was tested to determine HI reactions of serums from chicks not having previous experience with Newcastle virus. The chicks originated from the Experiment Station poultry flock which had no history of infectious diseases and periodic serum neutralization testing had given negative results. Chicks supplying the serums were subsequently found to be fully susceptible to Newcastle virus. Ages of the chicks ranged from 1 day to 10 weeks. For the entire group 74.8 percent of serums showed no inhibition or incomplete inhibition at the 1:2.5 dilution, and 22.6 percent showed complete inhibition at this dilution. Complete inhibition occurred with 2.6 percent of serums at dilution 1:5. None of the serums showed complete inhibition at dilution 1:10. The testing procedure employed 0.25 cc serial dilutions of serum and 5 hemagglutination units of virus.

Serological tests for Newcastle disease.—In a comparative study with the serum neutralization test and serial dilutions of serum for the hemagglutination inhibition (HI) test, it was determined that neutralization of 100 embryo LD₅₀ of Newcastle virus indicated that the chicken had experienced infection by the virus. With 5 hemagglutination units of virus in the HI test, inhibition titers of 1:20 were determined as positive, and titers of 1:10 were regarded as suspicious of Newcastle virus infection. With 10 hemagglutination units of virus, titers of 1:10 must be regarded as indicating existing or previous infection with Newcastle virus. A comparison of reactions, obtained with 5 and 10 hemagglutination units of virus, was made on 112 Newcastle

positive serums. Average titers of 77.6 and 55.0 were obtained for 5 and 10 units of virus respectively. The reactions were at the same titer in approximately 50 percent of the serums.

Vaccination for Newcastle disease.—A Newcastle disease virus of low virulence was studied for suitability as a living vaccine. The virus was administered intranasally to chicks without parental immunity at 5 days of age with losses of 1 percent or less. Vaccination of chicks as they were removed from the incubator resulted in death losses up to 10 percent. When chicks were vaccinated 10 days of age or older, losses were below 0.5 percent.

At 10 weeks of age, chicks vaccinated when 6 days old proved refractory to reinfection with a lot of virus that killed 100 percent of 35 unvaccinated chickens 7 weeks old. Another group, vaccinated at 3 days of age, were refractory to infection by a less virulent virus at 12 weeks of age.

As measured by in-vitro tests the immunogenicity of the virus is much lower than that of virulent strains of Newcastle virus. In most chickens the hemagglutination inhibition titers fall below significant levels within 60 days of vaccination. Duration of the serum neutralization titers has not been determined.

Development of hemagglutination inhibition (HI) titers in chicks.—A group of chicks were subjected to HI tests at 5, 6, 7, 8, 10, and 12 days following exposure to Newcastle disease virus. Positive titers had not developed in any of the chicks by the 5th day, but were present in 7.8 percent, 29.3 percent, 43.7 percent, 14 percent, and 4.7 percent of the chicks for the 6th to 12th days respectively. Titers of the chicks ascended slowly, reaching a peak at the 12th to 15th days. In a similar group of chicks vaccinated at an early age and challenged with active virus after their HI titers had fallen below diagnostic levels, the development of titer was more rapid, showing in chicks a significant increase on the 4th and 5th days after challenge. At the 6th day the titers were 4 to 16 times greater than those of chicks not challenged by the active virus. The difference in titer response makes it possible to determine whether chicks have previously experienced infection with Newcastle disease virus.

Susceptibility of hybrid and standard-bred chicks exposed to infection by the tapeworm *Raillietina cesticillus*.—A significant difference in susceptibility to infection with the tapeworm *Raillietina cesticillus* was demonstrated between a commercial variety of hybrid chicken and standard-bred New Hampshires. The hybrids appeared less susceptible to the effects of infection but possessed a lower threshold of infection as was evidenced by the greater development of the parasite in them. The ability of the tapeworm to retard weight gains in each group of test chickens indicated that infections with *R. cesticillus* are of greater economic importance than had been considered.

Diet of hens and development of worm parasites in their chicks.—Six groups of New Hampshire hens were fed either a corn-gluten-meal basal diet or a soybean-meal basal diet, supplemented with either 5-percent whitefish meal or 14 micrograms of vitamin B₁₂. Chicks from the six groups of hens were fed the same commercial starting and

growing ration, and were tested for resistance to parasitic infection. Significant differences were found in percentage development and lengths of the test parasite, the roundworm *Ascaridia galli*, grown in the six groups. Significant differences in growth of the six groups of chicks were also obtained following uniform exposure to $50 \pm$ infective eggs of the parasite.

Parasites of Kentucky chickens.—Two species of parasites, not previously recorded in the survey of parasites of Kentucky chickens, were recovered in postmortem examinations in 1949. *Raillietina echinobothrida*, a tapeworm, was first found in a chicken from Fayette county. The air-sac mite, *Cytolichus nudus*, was identified in hens from two flocks.

Age differences in virulence of eggs of worm parasite of chickens.—A study was made of weight gains achieved by 566 2-week-old New Hampshire chicks in the immediate 21-day period following exposure to $50 \pm$ infective eggs of the test parasite, the roundworm *Ascaridia galli*. It was found that greatest host injury, as expressed by failure to gain weight, resulted from exposure of chicks to infective eggs 14-21 days old. A decrease in virulence accompanied aging of the infective eggs.

DDT and infective chicken tapeworm larvae.—Some cysticeroids (infective larvae) of the tapeworm *Raillietina cesticillus* inside their immediate host, the confused flour beetle, were found to be capable of surviving at least 48 hours of continuous exposure of the intermediate host to 25-percent DDT. Numbers of tapeworms recovered from chicks fed beetles exposed to DDT indicated, however, that viability of the tapeworm larvae is reduced. It appeared that rapid mortality of cysticeroids did not begin until approximately 24 hours after death of the intermediate hosts.

Erysipelothrix rhusiopathiae infection in turkeys.—During the winter of 1948 the organism causing erysipelas in swine was observed, for the first time, to cause infection in turkeys in Kentucky. Only the toms were affected. Morbidity was approximately 40 percent in one flock and 10 percent in another flock. Mortality was under 10 percent in the first flock and negligible in the second. Erysipelas antiserum was administered to sick toms in doses of 20 cc and to unaffected toms in doses of 10 cc. Since no controls were used it was not possible to evaluate the benefit obtained from the serum. A group of 147 sick toms were treated with an injection of 300,000 units of penicillin in oil and wax, followed by 4 doses per day of 60,000 units each in a water in oil emulsion for 4 days. Only 2 of the toms receiving penicillin died.

A second outbreak of erysipelas infection occurred in the new stock on the farm during the fall of 1949. The morbidity and mortality was less severe than in the preceding outbreak. In this outbreak healthy toms were slaughtered and serum prophylaxis employed on those requiring finishing.

Growth and calcification of the femur, tibia, and metatarsus bones of male and female New Hampshire chickens, having straight keels.—At 2-week intervals from the 2nd to the 28th week

of growth, 5 male and 5 female New Hampshire chickens having straight keels, raised under normal conditions, were killed and the three larger leg bones, femur, tibia, and metatarsus, dissected out. The average gain in weights of the three bones was nearly the same in both sexes to the 8th week. From the 8th to the 26th week the bones of the males gained weight more rapidly. At the 12th week, the rate of gain of the bones of the females was slower until the approximate maximum weight of the metatarsus was reached at the 14th week, the tibia at the 18th week, and the femur at the 22nd week. The tibia, the longest of the three leg bones, increased in length more rapidly than the other two bones in both sexes to the 18th week. The lengths of the metatarsus and femur of the male and female were approximately the same to the 6th week at which time the rate of growth became more rapid in the males. The rate of increase in length of the femur and of the metatarsus was nearly the same for each sex during the experiment. The average approximate lengths of the femur and metatarsus of the females were reached by the 14th week and that of the males by the 16th week.

At two weeks of age the average volumes of the tibia, femur, and metatarsus were nearly the same in both sexes. After that the volume gradually increased at the same rate to the 6th week and then became more rapid to the 12th week, in both sexes.

At the 12th week there was a tendency to level off to the 16th week in all three bones. At this time the metatarsus of the female nearly reached its maximum volume. Between the 16th and 18th week the femur of the females increased rapidly to its maximum volume. From the 16th week, the volumes of the tibia of the female increased rapidly to the 20th week. The femur, tibia, metatarsus of the male increased to the 26th week.

The average percentage of ash in the three bones lowered slowly and irregularly from hatching time to the 16th week and then gained to the 26th week when that of the females tended to be higher than that of the males.

The percentages of calcium showed very little variation throughout the experiment in the three bones under consideration, in both sexes.

Growth and calcification of the femur, tibia, and metatarsus bones of male and female New Hampshire chickens having crooked keels.—At 2-week intervals, from the 8th to the 28th week, 5 male and 5 female New Hampshire chickens having crooked keels and raised under normal conditions were killed and the femur, tibia, and metatarsus bones dissected out. The weight, length, and volumes were determined on the dry bones and the percentages of ash determined in the fat-free dry bones. The average gains in weights of the three bones were nearly the same in both sexes to the 14th week, when those of the males became heavier. At this time, the metatarsus of the females reached its maximum weight while the other two bones failed to gain until after the 20th week when they increased rapidly to the 28th week. The bones of the males gained rapidly in weight until a break occurred between the 20th and 22nd week, and the gain thereafter was very little until the end of the experiment.

The three leg bones of the males increased in length to the 20th week. At this time the femur and metatarsus had reached approximate maximum length but the tibia increased in length slowly from the 22nd to the 28th week. A break occurred in the rate of increase in length in the three bones of the female at the 14th week, at which time the femur and metatarsus reached their maximum length while the tibia of the females increased very slowly to the 26th week.

The volumes of the three leg bones of the males gained steadily to the 20th week. From the 22nd to 28th week the femur increased again, and from the 26th to the 28th week the metatarsus and tibia increased. In the females the break occurred in all three leg bones between the 14th and 16th week when they again increased in volume, with the metatarsus and femur increasing to the 28th week and the tibia to the 26th week.

Percentages of ash in the three bones varied but little from the 8th to the 16th week at which time it began to increase slowly and irregularly in all bones to the 26th week when that of the females tended to be higher than that of the males.

The percentage of calcium showed very little variation throughout the experiment in the three bones under consideration, in both sexes.

Influence of vitamin D on the growth of New Hampshire cockerels, their combs, wattles, gonads, and uropygeal glands.—

Three lots of battery-raised New Hampshire cockerels were fed *ad libitum* a basal all-mash ration deficient only in vitamin D. Lot 1 received the low vitamin D ration while lots 2 and 3 received the same rations supplemented respectively with the optimum and ten times the optimum quantity of a vitamin D concentrate. At ages of 6, 10, 14, and 18 weeks, 5 chicks (2 small, 1 average size, and 2 large) were weighed and killed, and their combs, wattles, gonads, and uropygeal gland removed. These glands and appendages were measured and weighed. The increase in the average weight of the cockerels in lot 1 was much less than that of those in lots 2 and 3, which were substantially the same for the four periods.

The average weight and the average of the two longest axial diameters of the right and left wattles and gonads were approximately the same in each lot for each period. The average weight, length, and height of the comb, wattles, and gonads of the cockerels in lot 1 increased but little from the 6th to 18th week, were rudimentary and much smaller than those of lots 2 and 3. The growth of the uropygeal gland was approximately the same in the cockerels in the 3 lots and apparently was not influenced by the vitamin D in the mashes fed each lot.

The weight and linear dimensions of the combs, wattles, and gonads increased consistently from the 6th to the 18th week in lots 2 and 3, being larger in lot 3. Growth and general health conditions of the cockerels in lots 2 and 3 were approximately the same during this experiment.

Utilization by swine of rations containing distillers' dried solubles—Feeding tests conducted previously at this Station have shown a protein supplement composed of four parts soybean oilmeal and one part distillers' dried solubles to be fully equal to one composed

of two parts tankage, one part soybean oilmeal, and one part alfalfa meal for fattening pigs in drylot. Metabolism tests, using six pigs, were conducted on each of the following rations:

<i>Supplement</i>	<i>Ground Corn %</i>	<i>Tankage %</i>	<i>Soybean Oilmeal %</i>	<i>Alfalfa Meal %</i>	<i>Distillers' Solubles %</i>
Trio mixture	84.8	7.6	3.8	3.8	
Solubles and soybean oilmeal	84.0		12.8		3.2

Both rations contained slightly over 16 percent protein. The solubles were made from a mash bill of 56 percent corn, 23 percent rye, and 12 percent malt. They contained 24.42 percent crude protein.

The comparative utilization of the two rations is indicated by the following coefficients of apparent digestibility, which are averages for the same six pigs on each ration:

<i>Supplement</i>	<i>Dry Matter %</i>	<i>Crude Protein %</i>	<i>Ether Extract %</i>	<i>Crude Fiber %</i>	<i>N-free Extract %</i>	<i>Total Dig. Nutr. %</i>
Trio mixture	84.91	80.15	67.60	47.80	91.00	87.29
Solubles and soybean oilmeal	87.09	85.17	74.78	60.35	91.54	90.03

All of the differences in utilization proved to be statistically significant except that for nitrogen-free extract. In utilization of gross energy there was also a significant difference favoring the supplement containing the solubles. Percent of nitrogen storage was almost identical for the two rations.

Ladino clover vs. alfalfa pastures for fattening pigs.—Four lots of 10 pigs each were used in comparing alfalfa pasture with ladino clover pasture for swine. Lot 1 was grazed on alfalfa and received shelled corn, tankage, and mineral self-fed free-choice throughout the test. Lot 3 was fed in the same manner but grazed on first-year ladino clover. Lot 2 grazed on alfalfa and was self-fed shelled corn and mineral throughout the test, but received tankage self-fed only until the pigs averaged 100 pounds in weight. Lot 4 was fed the same as lot 3 but grazed on first-year ladino clover.

	<i>Lot 1 Alfalfa</i>	<i>Lot 2 Alfalfa</i>	<i>Lot 3 Ladino</i>	<i>Lot 4 Ladino</i>
Pasture forage	Alfalfa	Alfalfa	Ladino	Ladino
Average daily gain	1.61	1.57	1.73	1.53
Feed per 100-lb gain				
Corn	286.40	324.64	303.37	301.11
Tankage	25.13	6.50	23.07	5.34
Mineral	1.11	1.17	1.12	1.37
TOTAL	312.64	332.31	327.56	307.82

These results indicate little difference in the two pasture forages as tested. Lot 3 made the fastest gains, but required 15 pounds more feed per hundredweight gain than lot 1. Lot 4 required the lowest amount of feed per hundredweight gain, but took four days longer than any other lot to reach an average weight of 200 pounds.

The pigs ate the ladino with great relish. The corn used in this test was of low quality due to a large amount of damaged kernels and trash.

Relative value of dried corn distillers' solubles and condensed redfish solubles fed with yellow corn and soybean oilmeal to growing and fattening pigs on drylot.— Three replicated lots, of 10 pigs each, received *ad libitum* the following ration treatments: ground yellow corn and expeller soybean oilmeal with (1) 6 percent dried corn distillers' solubles; (2) 6 percent dried corn distillers' solubles fortified with vitamins A and D; and (3) 3 percent condensed redfish solubles. Crude protein was maintained at the same level in all rations. A simple mineral mixture and loose salt was fed free-choice. Average weight of the pigs was 42 pounds at the beginning of experiment. Results were as follows:

	Days fed	Average Weight	Lb feed per 100 lb gain	Feed cost per 100 lb gain
Lot 1	133	196.9	356	\$12.03
Lot 2	133	199.3	346	12.01
Lot 3	126	199.4	373	12.03

Experimental isohemolytic anemia of new-born pigs.— Beginning approximately 6 weeks before farrowing time, three pregnant gilts were given one subcutaneous and three intravenous injections of red blood cells from the boar to which they were bred. All of the gilts developed hemagglutinins and hemolysins for the boar's red cells. One gilt which was not immunized against the boar's cells farrowed 9 apparently normal pigs. Neither the colostrum nor the serum of this parturient gilt showed hemagglutinins for the red blood cells of the boar or pigs. Red cell counts on the pigs averaged 5 million/cmm. Two days later the counts ranged from 4 to 6 million/cmm and at 2 weeks were above 4 million/cmm.

The immunized gilts developed agglutinin and hemolysin titers of 1:8 and 1:10, 1:64 and 1:10, and 1:32 and 1:100, respectively. The agglutinin and hemolysin titers of their colostrum were 2 to 4 times stronger than those of their serum. Pigs farrowed by the sows were apparently normal at birth with normal blood counts, and their serums contained no agglutinins for the boar's cells. Cross-matching tests indicated that the pigs had inherited the red cell type of the boar.

Litters from the immunized sows were all dead at 42 hours in the 1st litter, 24 hours in the 2nd, and 12 hours in the 3rd. Blood counts on the dying pigs showed less than 1 million red cells/cmm. Hemagglutinin titers of 1:2 to 1:8 developed in the serum of the pigs following nursing, thereby demonstrating that the erythrocyte-destroying antibody in the sow's colostrum was absorbed by the pigs from the alimentary tract. The severity of the disease appeared to be directly related to the hemagglutinin and hemolysin titer of the colostrum.

The disease appeared to be entirely postnatal in pathogenesis as there was no indication of absorption of antibody by the fetus in utero. By placing 4 pigs with susceptible red cells on an immunized sow having a colostrum hemagglutinin titer of 1:32, it was shown that the pig probably loses most of its ability to absorb the antibody during the second day of life.

Nutritional treatment and reproductive performance of boars.— Six purebred Hampshire boars 7½ months old were allotted by lit-

ter mates into two groups and confined on concrete floors. Group I received a balanced ration of yellow corn, oats, tankage, soybean oil-meal, ground alfalfa leaf meal, and irradiated yeast. Group II received only yellow corn. Both groups were fed a mineral mixture free-choice. Semen collections were taken once a week, and blood samples were drawn at two-week intervals from each boar for the duration of the experimental feeding period, which was 170 days. After 132 days on feed, each boar in each group was bred to four gilts, and these were then slaughtered 25 to 31 days later.

After 100 days on feed the average semen volume and the average total sperm count were lower (but not significantly so) for the boars in Group II than in Group I. No difference was found in quality of sperm cells as judged by initial motility, storability, ability to reduce methylene blue, or percentage of abnormal cells present. At 90 days the vitamin A content of the blood from the boars in Group II was significantly lower and remained so for the duration of the feeding period. There was no significant change in vitamin C content of the blood from either group of boars.

In the gilts the percentage of normal embryos (based on corpora lutea number) was 62 percent for the boars in Group I and 63 percent in Group II. Dead embryos or resorbing placental sites accounted for an additional 15 percent of the ova in the gilts bred to the Group I boars. No dead embryos or resorbing placental sites were present in the gilts bred to the Group II boars. All of the gilts bred to the Group I boars settled to one service, while three of the gilts bred to Group II boars returned to estrus before the end of the 25-31 day period.

Death of embryo as a factor in conception rate in sheep.—A total of 120 yearling mottled-faced, northwestern-range ewes were artificially inseminated with undiluted semen from purebred Southdown rams early in the breeding seasons of 1948 and 1949. Sixty of the ewes were slaughtered the third day after insemination, and the ova were recovered from the reproductive tracts and examined for fertility. The remaining sixty ewes (control ewes), for a period of 60 days after insemination, were checked daily for return to estrus.

Results for the two seasons were combined. All of the slaughtered ewes had ovulated, and 93.5 percent of the ova were recovered, leaving 6.5 percent unaccounted for. Of the ova recovered, 51.2 percent were fertilized, but 13.6 percent of these were classified as abnormal, and 23.8 percent of the unfertilized ova were classified as abnormal. Including all ova, both fertilized and unfertilized, 18.6 percent were classified as abnormal on the third day after the ewes were inseminated.

Though 57 percent of the slaughtered ewes yielded one or more fertilized ova, only 33 percent of the ewes in the control group lambled. In this study the reproductive loss from ovulation to lambing was 67 percent, and the loss by death of embryo from fertilization to lambing was 42 percent.

Effect of thyroprotein and progesterone on occurrence of first estrus in anestrual ewes.—Four groups of seven ewes each were placed on experimental treatment (June 27-July 11) during the anestrual season of 1949. One group served as a control group, a

second group received a daily subcutaneous injection of 10 milligrams of progesterone, a third group was given orally 1 gram of thyroprotein (protamone) daily, and a fourth group was given 10 milligrams of progesterone and 1 gram of thyroprotein daily. The ewes were checked daily for estrus with teaser rams from the beginning of treatment. None of the treatments shortened significantly the average interval from end of treatment to first estrus. The interval was significantly longer in the thyroprotein-treated group, and the variance for this group was only one-third that for the control group. Neither progesterone alone nor progesterone and thyroprotein together had any effect on the interval. The average interval from the end of treatment to occurrence of first estrus for the four groups was as follows: control group, 47.3 days; progesterone group, 51.6 days; thyroprotein group, 62.1 days; and progesterone-thyroprotein group, 44.9 days.

Growth of lambs infected with tapeworms.—Four 3-months-old parasite-free lambs weighing 19.0, 20.0, 20.5, and 21.5 pounds were exposed, respectively, to 5, 20, 120, and 80 cysticeroids of *Moniezia expansa*. The uninfected control lamb weighed 21.0 pounds when the experiment began. The lambs were weighed weekly. Proglottids of *M. expansa* were recovered from three of the exposed lambs 33 days after exposure, and from the 4th lamb 42 days after exposure. The following gains in weight, 121 days after exposure, were recorded: the lamb which received 5 cysticeroids, 34.5 pounds; the lamb which received 20 cysticeroids, 29.0 pounds; the one which received 80 cysticeroids, 31.0 pounds; and the one which received 120 cysticeroids, 25.0 pounds. The control lamb over the same period gained 34.5 pounds. Sixty-four days after exposure to cysticeroids all the exposed lambs had spontaneously expelled their tapeworms.

The "standard" phenothiazine drench for sheep.—Three yearling wethers, raised parasite-free in confinement, were exposed to contaminated pasture for a period of 4 weeks. Two weeks later they were each drenched with 2½ oz of 37-percent phenothiazine suspension (1 oz total phenothiazine), and a postmortem examination was held 72 hours later. A fourth yearling wether, raised and exposed with the other three animals, but not treated, was given postmortem examination at the same time.

At postmortem the untreated wether was parasitized by 502 *Haemonchus contortus* (the eastern stomach worm), 830 *Ostertagia* sp. (western stomach worm), 42 *Trichuris ovis* (whipworm), 6 *Oesophagostomum columbianum* (nodular worm), and 7 *Moniezia expansa* (tape-worm). The three treated wethers averaged 1 *Nematodirus spathiger*, (thread-necked strongyle), 42 *Trichuris ovis*, and 5 *Moniezia expansa*. The 1 oz of phenothiazine was effective against the two stomach worm species and nodular worms, but was not effective against the whipworms and the tapeworms.

Winter survival on pasture of worm parasites of sheep.—A test plot of permanent pasture (bluegrass, wildgrasses, and white clover) was contaminated with feces of parasitized ewes in October and November 1948. Three weeks of exposure on the plot in May 1949, 5-6 months after contamination, established worm-parasite infections in two lambs and two yearling wethers previously free of parasites. The

species of parasites demonstrated to survive winter were the round-worms *Haemonchus contortus*, *Ostertagia circumcincta*, *O. trifurcata*, and *Nematodirus spathiger*; and the tapeworm, *Moniezia expansa*.

The two test lambs at postmortem averaged 5.5 specimens of *Haemonchus contortus*, 105 *Ostertagia* sp., 144 *Nematodirus spathiger*, and 0.5 *Moniezia expansa*. The two yearling wethers (bottle-fed and maintained parasite-free for over a year in raised wire-floored cages) averaged 57.5 specimens of *Haemonchus contortus*, 144 *Ostertagia* sp., 373.5 *Nematodirus spathiger*, and 8.5 *Moniezia expansa*. These heavier infections of the wethers were ascribed to greater consumption of the contaminated vegetation.

Specificity for sheep parasites, of the complement fixation test using whole-worm antigens.—Whole-worm antigens of *Haemonchus contortus*, *Trichostrongylus* sp., *Nematodirus spathiger*, *Ostertagia* sp., and *Moniezia expansa* from sheep were prepared with the aid of the Waring Blender. Serum was obtained from five laboratory-reared lambs, each of which had a pure infection with one of the above species of parasite. The complement fixation test under these conditions showed no specificity. For example, when the *H. contortus* antigen was employed with serum from lambs infected with the other four species of parasites, the complement was fixed at serum dilution of 1-40. In most cases the heterologous titers were as high as the homologous titers.

Intake and nutritive value of forages consumed by grazing wethers.—Six yearlings and 12 lambs out of Western ewes and by Southdown rams were permitted to graze for 2-week periods on a variety of pure forages, all of which were in a young, rapidly-growing condition. Dry-matter intake, organic-matter digestibility, and digestible protein content of the forages were calculated with the following results, expressed on the dry-matter basis:

Forage and Number of Observations	Digestible Protein	Digestible Organic Matter	Intake of Digestible Organic Matter
	%	%	lb
Ky 31 fescue (10)	9.0	68	1.03
Orchard grass (9)	8.8	64	1.17
Lincoln bromegrass (9)	14.2	74	1.58
Alfalfa (3)	16.0	73	1.66
Timothy (3)	8.7	72	1.67
Ky 215 red clover (2)	16.2	76	1.84
Kenland red clover (6)	17.8	74	1.91
Redtop (3)	7.5	74	2.08
Ladino clover (6)	19.8	89	3.15

The lambs consumed over three times as much digestible organic matter while grazing on ladino clover as they did while grazing on fescue. In the former case sufficient nutrients were consumed to produce maximum gains whereas in the latter case the intake was insufficient even for maintaining weights.

Corn as a replacement for most of the hay in the ration of pregnant and lactating ewes.—Two lots of 10 yearling, Hampshire-cross western ewes each were fed from December 10 to April 22 in dry-lot. Group 1 consumed an average daily ration of 3.72 pounds of good alfalfa hay and 0.51 pound of shelled yellow corn per ewe. Group 2 was fed an average daily ration of 1.15 pounds of the same alfalfa hay

and 1.71 pounds of shelled yellow corn per ewe. Both groups had access to an outside paved lot. Salt, bonemeal, limestone, and water were available at all times.

Average daily gains of the ewes were identical in the two lots. The group 2 ewes carried slightly more finish at the close of the experiment. Eight ewes lambled in each lot, producing nine lambs in group 1 and 11 lambs in group 2. At birth the lambs in the two lots did not differ significantly in weight or strength, but at 56 days of age the lambs in group 1 weighed nearly twice as much as those in group 2. The group 2 ewes exhibited increasingly poor appetites, lack of vigor, and scanty milk flow. The ration of this lot was evidently deficient in protein, vitamin A, and possibly other factors needed for adequate milk flow.

Supplemented cottonseed hulls as a roughage for fattening lambs.—Three groups of 10 western feeder lambs each were placed on feed at an average weight of 55.2 pounds per lamb. Group I received a ration of 45 percent alfalfa hay and 55 percent cracked yellow corn. Group II received a ration of 29.9 percent cottonseed hulls containing 10 percent molasses, 50.6 percent cracked yellow corn, 15.5 percent cottonseed meal, and 4.0 percent alfalfa meal. Group III received a ration of 55.6 percent cracked yellow corn, 28.0 percent plain cottonseed hulls, and 16.4 percent cottonseed meal. All groups received ground limestone and salt at will. Each group of lambs was given all the feed they would clean up. All three groups ate approximately the same total amounts of feed, although Group III reached full feed quickest and then fell behind the other two groups during the last five weeks of the test. This would indicate a vitamin A depletion.

The summarized data were as follows:

	<i>Group I</i>	<i>Group II</i>	<i>Group III</i>
Lambs per lot	10	10	10
Days on feed	98	105	112
Average initial weight (lb)	54.2	55.4	56.0
Average final weight (lb)	88.9	88.8	85.5
Average daily gain (lb)	.354	.318	.263
Average daily feed (lb)	2.37	2.34	2.28
Pounds feed per lb gain	6.70	7.36	8.65

In a similar test last year the average daily gains for the three lots were .400, .326, .183 pounds and the average daily feed intakes were 2.76, 2.53, and 1.67 pounds, respectively. The performance of Lot III in the second test was considerably improved.

Utilization by sheep of rations containing distillers' by-products.—Six yearling wethers were used in standard metabolism tests to determine their utilization of three rations. The first ration was composed of 50 percent timothy hay, 45 percent ground yellow shelled corn, and 5 percent soybean oilmeal. The second ration was composed of 50 percent timothy hay, 40 percent ground corn, and 10 percent corn distillers dark grains. The third ration was composed of 50 percent timothy hay, 40 percent ground corn, and 10 percent corn distillers dried solubles.

All rations were very similar in chemical composition and contained about 10 percent of crude protein. The "dark grains" were produced from a mash bill of 90 percent corn and 10 percent barley malt. They contained 28.50 percent crude protein on a dry basis. The

solubles were produced from a mash bill of 65 percent corn, 23 percent rye, and 12 percent barley malt. They contained 27.65 percent crude protein on a dry basis.

The average coefficients of apparent digestibility for the three rations were as follows:

<i>Supplement</i>	<i>Organic Matter</i>	<i>Crude Protein</i>	<i>Ether Extract</i>	<i>Crude Fiber</i>	<i>N-free Extract</i>	<i>Gross Energy</i>
Soybean oilmeal	72.28	60.27	75.72	43.18	82.74	69.47
Distillers dark grains	74.07	61.71	79.27	50.72*	82.74	72.27*
Distillers dried solubles	73.25	61.06	77.01	43.07	83.50	70.96*

* Statistically significant higher utilization than in ration containing soybean oilmeal. Other differences not statistically significant.

The gross energy in the ration containing soybean oilmeal was 58.68 percent metabolizable, as compared with 61.43 percent of the energy in the dark grains ration and 59.78 percent of the energy in the ration containing distillers solubles.

Comparative carcass characteristics of Kentucky spring lambs and western fed lambs.— Fifty Kentucky spring lambs (5 lots of 10 lambs each) and 30 western fed lambs (3 lots of 10 lambs each) have so far been studied in this project. The first three lots of Kentucky lambs were purchased from farmers near Lexington, the other two lots were from a local stockyard. The three lots of western lambs were purchased as feeders and then fattened on the Experiment Station farm, using standard corn-belt feeding practices.

The finished lambs and their carcasses were graded, a cross section was taken of a leg from each carcass at the widest point and of the rib and loin from each carcass. Cross-section areas of the leg and rib eyes were determined by the planimeter method. In chemical analyses of the rib eye, the only significant difference found was a higher phosphorus content in the carcasses from the Kentucky lambs.

In this study the Kentucky spring lambs graded higher, were in better condition, had better conformation, higher dressing percentage, higher percentage of edible meat, lower percentage of bone, and a higher proportion of high-priced meat, than the western lambs. In 3 of the 5 lots of Kentucky lambs the legs averaged a higher percentage of the carcass than did those of the fed western lambs.

Lignin recovery in digestion trials and influence on digestibility of dry matter by lambs and steers.— Six lignin balances were conducted with steers and 16 with lambs. In the steer trials, the average recovery of lignin fed was 112 ± 12 percent, while in lamb trials the average lignin recovery was 101 ± 9.5 percent. Some studies were conducted in an attempt to determine whether the nature of the material isolated as lignin from feeds is the same as that from feces. No differences were found in methoxyl determinations of lignin isolated from these sources.

From the data of grazing trials, regression equations were calculated to illustrate the effect of lignin content (x) on dry-matter digestibility (y). Our earlier investigations had shown that lignin content of forages was the best single chemical measure of digestibility of dry matter. The equations obtained from the 1949 data and from the combined data of 1947 and 1948 were as follows:

	1947 and 1948	1949
Lambs	$Y = 95.7 - 5.18x$	$Y = 98.4 - 5.39x$
Steers	$Y = 96.0 - 4.49x$	$Y = 96.0 - 4.47x$

Use of protein as an indicator of intake and digestibility of pasture forage by lambs and steers.—Data from lignin ratio and protein ratio (using Mitchell's exponential equation, $Y = aX^b$) methods of determining dry-matter digestibility in grazing trials gave similar average results in both steer and lamb trials. The regression coefficient, however, was lower for the protein ratio method (1.92) in the lamb trials than for the lignin ratio method (5.18). In the steer trials, the regression coefficients were not statistically different, being 4.49 for the lignin ratio and 4.66 for the protein ratio methods.

Digestible nutrients in Ky 31 fescue silage fed to lambs and steers.—Ky 31 fescue approximately 18 inches in height was harvested in mid-October and ensiled with the addition of 60 pounds blackstrap mollasses per ton of forage. This forage, which was supplied by the Kentucky 31 Fescue Association, had been grown on sandy-clay soil in Breckenridge county during a dry season and was not as succulent as spring and early summer forage. It also contained about 12 percent of sycamore leaves.

The silage was fed to six 2-year-old feeder steers and to six yearling wethers in standard digestion trials to determine the digestibility of its nutrients, which was found to be as follows:

	Dry Matter %	Crude Protein %	Ether Extract %	Crude Fiber %	N-free Extract %
Steers	60.68	54.51	51.14	66.72	63.97
Wethers	50.73	46.98	45.92	50.66	56.69

These results indicate a poorer utilization of the fescue by sheep than by steers. This agrees with results from this Station on the comparative digestibility of fresh fescue forage by steers and by sheep.

Digestion trials with steers have been previously conducted at this Station on Kentucky bluegrass, alfalfa, and corn silages, all made from forages rated as being of good to very good quality grown at the Experiment Station farm at Lexington. The average contents of digestible crude protein and total digestible nutrients of these forages are listed for comparative purposes. All are on a dry-matter basis. Fresh silage contains approximately one-third dry matter.

	Ky 31 Fescue %	Kentucky Bluegrass %	Alfalfa %	Corn %
Digestible crude protein	5.5	13.5	12.8	4.9
Total digestible nutrients	58.2	68.7	58.3	69.5

Intake and nutritive value of forages consumed by grazing steers.—Eight grade yearling Hereford feeder steers were permitted to graze for 2-week periods on a variety of pure forages. Dry-matter intake, dry-matter digestibility, and digestible crude protein content of the forages were calculated with the following results, all expressed on the dry-matter basis:

<i>Forage and Number of Observations</i>	<i>Digestible Protein %</i>	<i>Digestible Organic Matter %</i>	<i>Intake of Digestible Organic Matter lb</i>
Ky 31 Fescue (17)	10.7	70	9.0
Bluegrass (6)	9.6	69	10.5
Orchard grass (5)	13.0	73	11.7
Alfalfa (3)	17.2	77	13.3
Ladino (5)	17.6	84	18.8

The extremely favorable results obtained with ladino clover agree with those obtained last year with both steers and lambs.

Distillers' dried solubles vs. soybean oilmeal as a supplement for wintering stocker steers.—Two lots of steers, each containing 16 long-yearling Western grade Hereford stockers averaging 926 pounds in weight on November 5, were wintered for 145 days on an average daily ration of 30 pounds corn silage, 6 pounds mixed grass hay, and 1 pound protein supplement per steer. The protein supplement fed to group 1 was soybean oilmeal, whereas group 2 received distillers' dried solubles. Fine-ground limestone, salt, and water were available at all times. The average daily gains per steer were 0.87 pound for group 1 and 0.90 pound for group 2. This difference was not significant.

From March 30 to July 25, all 32 steers were grazed together on mixed pasture of fair quality. Average daily gains for the two lots (1.24 and 1.27 pounds per head, respectively) were not significantly different. Likewise there was no significant difference in carcass yield or carcass grade. For all practical purposes, these two protein supplements appear to be of equal value for wintering stocker steers.

By-products of grain fermentation for use in steer rations.—Three lots of 10 700-pound western Hereford feeder steers were fed in drylot for 182 days. Lot 1 got all the ground yellow shelled corn they would consume, but no protein supplement. Lot 2 was fed 80 percent as much corn as lot 1 ate, plus the distillery residue (dark grains) from the remaining 20 percent. Lot 3 was fed the same mixture as lot 2 (92.56 percent ground yellow corn and 7.44 percent corn dark grains) but this mixture was fed to the limit of the steers' appetites. All lots were fed 2 pounds of grass hay and 3 pounds of wheat straw per steer per day. Salt, ground limestone, and water were available at all times.

The average daily gains per steer were: lot 1, 1.02 pounds; lot 2, 1.12 pounds; and lot 3, 1.59 pounds. The lot 2 steers outgained the lot 1 steers by 10 percent even though they were fed 13.6 percent less total concentrates containing 2.5 percent less total crude protein. On 100 bushels of corn, lot 1 steers gained 463 pounds. On 80 bushels of corn plus the distillery residue from 20 bushels, lot 2 steers gained 510 pounds. Steers of lot 3 produced faster and cheaper gains than those of lot 2, because of larger feed intake and therefore a proportionately greater use of feed for gain.

Standard digestion experiments were completed using six steers on the rations fed to lots 1 and 2. The average digestibilities of the nutrients in each ration were found to be as follows:

	<i>Crude Protein %</i>	<i>Ether Extract %</i>	<i>Crude Fiber %</i>	<i>N-free Extract %</i>	<i>Total Dig. Nutr. %</i>
Ration 1	47.60	49.97	42.71	76.71	66.75
Ration 2	49.33	50.04	45.49	76.74	67.25

None of these differences were statistically significant, but when coupled with results of the steer-feeding tests, they indicate a slightly better utilization of the ration fed to lot 2.

Utilization by steers of distillers' dark grains produced by malt and by fungal amylase fermentations.—Six 2-year-old Hereford feeder steers were used in standard digestion trials on two rations. Each steer received 11 pounds of grain mixture, 2 pounds of grass hay, and 2 pounds of wheat straw daily. One grain mixture was composed of 92.6 percent ground yellow corn and 7.4 percent distillers' dark grains made from the standard malt fermentation. The other grain mixture was the same except its dark grains were produced by fungal amylase fermentation. The average coefficients of apparent digestibility for the two rations were as follows:

<i>Type of Dark Grains</i>	<i>Dry Matter</i>	<i>Crude Protein</i>	<i>Ether Extract</i>	<i>Crude Fiber</i>	<i>N-free Extract</i>
Malt	67.44	48.66	67.45	41.84	75.79
Fungal amylase	66.42	48.33	69.58	41.76	74.34

The differences were not statistically significant. The new fungal amylase process evidently produces distillers' dark grains fully equal in digestibility by steers to those produced by the standard malt fermentation.

Distillers dark grains, soybean oilmeal, or cottonseed meal as protein supplements for steers fattened in drylot.—Three lots, each composed of 10 good-to-choice western long yearling Hereford steers averaging 764 pounds in weight, were full-fed for 126 days in drylot. Each steer in lot 1 ate an average daily ration composed of 14.11 pounds of yellow shelled corn, 4.44 pounds of grass hay, and 1.66 pounds of cottonseed meal. The average daily ration for lot 2 was 13.48 pounds of yellow shelled corn, 4.44 pounds of grass hay, and 1.66 pounds of expeller-process soybean oilmeal. Lot 3 steers were fed an average daily ration of 12.12 pounds of yellow shelled corn, 4.42 pounds of grass hay, and 2.42 pounds of distillers dark grains. These dark grains were made from a mash bill composed of 79 percent corn, 9 percent rye, and 12 percent barley malt. The steers always had access to salt, limestone, water, and an outside paved lot. They were sprayed with DDT for the control of flies at 2- to 4-week intervals, as needed.

The average daily gains were: Lot 1, 1.80 pounds; lot 2, 1.92 pounds; lot 3, 1.72 pounds. Dressing percentages for the three lots were 60.76, 60.57, and 59.42 percent, respectively. The average carcass grades for the three lots were "U. S. Good plus," "U. S. Good," and "U. S. Good minus." Even though the steers in lot 2 outgained those in lot 1, their carcasses showed somewhat less marbling and covering of fat. After the first two weeks, the lot 3 steers ate less feed than those in either of the other two lots.

Serum levels of penicillin in cattle.—With doses of 500 units per pound of body weight, intramuscular injection of penicillin in oil and wax resulted in serum level responses varying from 9 to 12 hours in duration with an average of 10 hours. With intramuscular injection of doses of 1,000 units per pound, the measurable serum level response

varied from 6 to 16 hours, with an average duration of 11 hours. Using procaine penicillin in oil intramuscularly, with doses of 1,000 units per pound, detectable serum levels were maintained for 9 to 18 hours, averaging 12 hours. Doses of 2,000 units per pound resulted in serum level durations of 12 to 24 hours, with an average of 16 hours. For doses of 4,000 units per pound, procaine penicillin in oil maintained measurable serum levels for 24 hours in all of 6 trials. With crystalline penicillin G in aqueous solution, measurable serum levels were maintained for 3 to 5 hours with doses of 500 units per pound, and for 4 to 7 hours with doses of 1,000 units per pound.

Diseases of new-born foals.—Postmortem and bacteriological examinations were made on 78 foals. The infectious agents responsible for death were *Shigella equuli* in 15, streptococci in 9, *Escherichia coli* in 2, and the virus of equine abortion in 3. Anatomical disorders and gross pathological lesions not associated with bacterial infection were responsible for death of 25 foals and hemolytic icterus was observed in 4. Cause of death in 20 foals could not be determined. In several of these the clinical history and pathological changes in the tissues were characteristic of bacterial infection, but antibiotic and sulfonamide sterilization of the tissues evidently prevented establishing an etiological diagnosis.

Aborted equine fetuses.—A total of 140 aborted fetuses were studied by bacteriological, histological, and gross examination of tissues and organs. The causes of abortion were twin pregnancy in 23, virus infection in 48, streptococci in 6, *Escherichia coli* in 4, *Pseudomonas aeruginosa* in 1, and malformation, dystocia, and twisted umbilical cord in 1 case each. In 55 cases the cause of abortion could not be determined.

Genital infections of mares.—In 1949, 628 bacteriological cultures from the genital tract of mares were examined. Of these cultures, 389 were negative, 181 contained streptococci, 21 contained *Escherichia coli*, 18 contained staphylococci, 18 contained *Pseudomonas aeruginosa*, and 1 contained an organism of the Klebsiella group. This study was conducted to determine the infectious agent present in cases of cervicitis or metritis and to determine results of treatment for various genital infections.

Incidence of equine virus abortion.—During the current foaling season a diagnosis of virus abortion was made in 44 cases by examination of aborted fetuses and fetal tissues. In all cases the diagnosis was established by the presence of intranuclear inclusion bodies in the hepatic cells or bronchial and alveolar epithelium. Outbreaks occurred on 13 farms in Kentucky and accounted for 22 of the cases presented for diagnosis. The Kentucky outbreaks occurred in breeding establishments in the Lexington and Louisville areas. Outbreaks were diagnosed at one breeding establishment each in Indiana, Ohio, Oklahoma, Pennsylvania, and New Jersey, accounting for 22 of the cases examined. In addition to the states mentioned above the disease has been diagnosed as a cause of abortion in mares in North Carolina, Virginia, Maryland, California, Tennessee, Michigan, and Canada.

Vaccination for equine virus abortion.—A total of 1,624 mares bred for the 1949 foaling season were vaccinated in the fall of 1948. Of these mares, 1,197 were located in Kentucky and 427 in other areas. Five of the vaccinated mares aborted virus-infected fetuses, though in one of these instances it was learned that recommended procedure for vaccination was not followed. Virus-infected fetuses were aborted by nonvaccinated mares on 14 farms, of which 10 were in Kentucky. On 2 Kentucky farms the remaining pregnant mares were not vaccinated, because they were too far advanced in the gestation period to obtain benefit from vaccination. On the other 8 Kentucky farms, 170 mares that had not received vaccine in the fall were vaccinated after virus-infected fetuses had been aborted. Subsequent to vaccination, the mares aborted 7 virus-infected fetuses during an interval of 1 to 58 days following administration of the vaccine. Pregnant mares were vaccinated subsequent to the appearance of virus infection on 3 farms outside of Kentucky. On 1 farm, 24 mares were vaccinated and no more abortions from virus infection occurred. In another group, 34 mares were vaccinated after 8 virus abortions had occurred; 14 mares aborted within 25 days following the first dose of vaccine. Abortions also occurred on the 31st, 34th, and 64th days. The remaining 17 mares produced normal foals.

On the 3rd farm, 89 mares were vaccinated following abortion of 9 virus-infected fetuses. Thirteen of these mares aborted during the period required for the vaccination series. During a 32-day interval following vaccination, abortions occurred in 38 additional mares. The remaining 38 mares produced normal foals.

Experimental studies on equine virus abortion.—Following failure to establish infection with the virus of equine abortion in embryonated chicken eggs in 1948, further attempts were made this year to cultivate the virus. The inoculum used consisted of suspensions prepared from lungs and liver of virus-infected equine fetuses. This was injected into duck embryos 10 to 12 days of age, into one-day old hamsters intraperitoneally, and into pregnant guinea pigs intraperitoneally, without success in establishing the infection. However, results from intra-uterine inoculation of guinea-pig fetuses on the 35th day of gestation indicated that it may be possible to adapt the virus of equine abortion to the guinea-pig fetus. In three instances, material which was passed from virus-infected equine fetuses through guinea-pig fetuses to pregnant mares resulted in abortion of virus-infected fetuses. Inoculum derived from the 3rd serial passage in guinea-pig fetuses failed to induce abortion in pregnant mares.

***Pseudomonas aeruginosa* from aborted equine fetuses.**—One equine fetus, aborted at the 8th month of gestation, showed widely distributed hemorrhagic lesions and had an unusual sour putrefactive odor. The tissues were extensively autolyzed and it was estimated that the fetus had been dead in utero from 1 to 3 days. Bacteriological examination resulted in isolation of pure cultures of *Pseudomonas aeruginosa* from the heart blood, lungs, liver, spleen, and stomach contents. Another abortion due to this organism was observed previously in a fetus aborted during the 7th month of gestation. This fetus also showed considerable autolysis, having been dead 2 or 3 days before

being expelled from the uterus. This bacterium is infrequently found infecting the genital system of mares, and is very difficult to eliminate by treatment. Such mares usually do not conceive. It is not known whether the abortions resulted from infection existing at the time of breeding or from invasion of the uterus in later stages of gestation.

Septicemic infections of new-born foals.— In 1948 and 1949, when streptomycin and penicillin were widely used in treatment of septicemia in foals, *Sh. equuli* was found as the cause of death in foals examined at this Station 55 percent less frequently, and streptococci 31 percent less frequently, than in 1921-43, before the use of these drugs or of the sulfonamides. Likewise *Sh. equuli* was found as the cause of death in foals 39 percent less frequently, and streptococci 12 percent less frequently in 1948 and 1949 than in 1944-47, when sulfonamides were chiefly used in treatments of those infections.

Blood picture of Thoroughbred nursing mares and barren mares.— Between July 7 and July 19, 1949, a study was made of the blood picture of Thoroughbred nursing mares and barren mares on two Thoroughbred farms. The barren mares on the two farms had higher average blood values than the nursing mares. The following average blood values of 10 barren mares were recorded from farm 1: erythrocytes, 9,400/cmm; hemoglobin, 13.18 gm/100 ml; leucocytes, 9,800/cmm; packed volume of erythrocytes, 41.7 percent. The average blood values of 10 nursing mares at this same farm were: erythrocytes, 8,410,000/cmm; hemoglobin, 12.05 gm/100 ml; leucocytes, 8,900/cmm; packed volume of erythrocytes, 36.4 percent. At farm 2, 10 barren mares had the following average blood values: erythrocytes, 10,000,000/cmm hemoglobin, 13.87 gm/100 ml; leucocytes, 11,900/cmm; packed volume of erythrocytes, 42.2 percent. The following average blood values were recorded from 10 nursing mares: erythrocytes, 8,500,000/cmm; hemoglobin, 12.33 gm/100 ml; leucocytes, 8,800/cmm; packed volume of erythrocytes, 36.6 percent.

Comparison of the red cell count and hemoglobin content of blood of Thoroughbred weanling colts and fillies.— The mean red blood cell count of 33 weanling fillies and 37 weanling colts was 11,280,000 cells/cmm and 11,200,000 cells/cmm, respectively. The mean hemoglobin content of the blood of fillies was 12.09 gm/100 ml and of the colts 11.87 gm/100 ml. Even though the fillies showed slightly higher mean values for the number of erythrocytes and hemoglobin content, the differences between the mean values for fillies and colts were not statistically significant.

Size of red blood cells in relation to age of Thoroughbred foals.— Two hundred erythrocytes were measured and average area calculated for each of nine Thoroughbred foals. This test was repeated about every 14 days for about 4 months. The resulting data included foals ranging from 2 to 150 days old. When the average area of the erythrocytes was plotted on the ordinate against days of age on the abscissa, the points formed a very narrow band almost parallel to the abscissa. Such an arrangement of points would indicate no change in the mean size of the erythrocyte in foals up to 150 days old. A statistical test for correlation likewise indicated no change in the mean size of the erythrocyte over the test period.

Blood picture of horses on various amounts of low-level phenothiazine.—No significant differences were found in the erythrocyte counts of four horses fed 0.5 gm, 1.0 gm, 2.0 gm, and 4.0 gm of phenothiazine daily for 14 months. The erythrocyte counts at the end of a 14-month test were comparable to, or higher than, the pretreatment counts. Hemoglobin concentrations were higher during the last 2 months of the experiment than during the pretreatment period. Mean corpuscular hemoglobin concentration and mean cell volume remained fairly constant throughout the experiment. At postmortem examination, none of the 4 horses showed significant macroscopical structural changes. Sections of the liver, heart, lungs, kidneys, and spleen were examined.

Blood picture of Thoroughbred foals in relation to season.—A series of six blood tests were made on nine Thoroughbred foals at approximately 14-day intervals for 4 months, beginning April 19. The average red blood cell count was 11,590,000 cells/cmm at the beginning of the experiment, rose to 13,600,000 cells/cmm by May 11, maintained a level of 13 million cells/cmm or more through June 7, declined to 12,500,000 by June 21, and declined further to 11,400,000 by July 5. A similar progression was observed for the packed volume of erythrocytes. Hemoglobin content followed a similar but much less marked progression. The average leucocyte count of these foals rose from 10,300 cells/cmm on April 19 to a peak of 13,200 cells/cmm on May 24, and then maintained a level of 12,000 to 13,000 cells/cmm through July 5.

Differences between the average red blood cell counts in April, in May through June 7, and from June 7 to July 5 were statistically significant. Differences between the average hemoglobin content over the same period were not statistically significant. There was no apparent correlation between blood values and age of foals.

The progression and high peaks in the hemoglobin, erythrocyte count, and packed volume of erythrocytes came when bluegrass pasture was actively growing, while low average blood values were in late June and July when pastures were mature or dormant.

Blood picture of Thoroughbred mares in foal.—A study of the blood of 65 healthy Thoroughbred mares in foal revealed the following mean values with their standard errors: red blood cells/cmm, $10,500,000 \pm 0.102$; hemoglobin, 14.89 ± 0.128 gm/100 ml; packed volume of erythrocytes, 45.10 ± 0.362 percent; leucocytes $10,000 \pm 0.187$ cells/cmm; mean cell volume, 49.92 ± 0.253 cubic microns; mean corpuscular hemoglobin concentration, 32.96 ± 0.115 percent. The mean differential counts in percent with their standard errors were: neutrophils, 49.19 ± 1.004 ; lymphocytes 43.79 ± 1.126 ; monocytes, 2.68 ± 0.154 ; eosinophils, 3.65 ± 0.238 ; basophils, 0.66 ± 0.093 .

Results of Chi-square tests of agreement between the observed and theoretical distributions of the above blood values according to the normal curve, together with a measure of skewness, indicated that the normal curve of error is applicable to the distribution, with the possible exception of the hemoglobin and packed volume of erythrocytes.

The oribatid mite, *Galumna virginienensis*, a possible intermediate host for the horse tapeworm, *Anoplocephala perfoliata*.— One hundred oribatid mites of the species *Galumna virginienensis*, dissected from cultures of these mites were exposed 3 months to the ova of the horse tapeworm. One cysticeroid was found in each of two mites. The mites used in the cultures had been collected from sod which had not been exposed to horses or sheep. The possibility that the recovered cysticeroids were those of anoplocephalid tapeworms occasionally found in rodents seemed rather remote. No effort was made to infect a horse with these few cysticeroids.

Hemolytic icterus of foals.— During the 1949 foaling season, 20 mares known to be capable of producing foals with isohemolytic anemia and icterus were under observation, and 10 others which produced jaundiced foals for the first time were observed. Five mares sensitized against certain erythrocyte antigens were bred to stallions whose red cells were compatible with the serum of the mare. The foals were normal and were allowed to nurse their dams at will without evidence of icterus or anemia. On the other hand sensitized mares bred to stallions with red cells incompatible with the serum of the mare exhibited a rise in titers of hemagglutinin and hemolysin in the late stages of pregnancy if the fetus inherited the red cell type of the stallion. Where the foal inherited red cells like those of the dam there was no rise in hemagglutinin or hemolysin titers. This information makes it possible to predict the appearance of hemolytic icterus in the new-born foal and arrange in advance for its care and treatment.

In supervising the care of foals from incompatible matings it was learned that hand milking or permitting another foal to nurse the mare for 24 to 36 hours changed the character of the mammary secretion from colostrum to normal-appearing milk, and the hemolysin and hemagglutinin titer of the secretion was greatly reduced. The mare's own foal then could nurse her without being exposed to a high concentration of erythrocyte-destroying antibody in the colostrum. Moreover, it was found that foals 36 hours old, or older, no longer absorb a significant quantity of antibody from the alimentary tract.

Studies on the pathogenesis of the disease indicated that the hemolysin titer of the colostrum has greater influence on the severity of the disease than the agglutinin titer. Mares having both high hemolysin and agglutinin titers produced foals with very severe isohemolytic disease. In general, foals nursing colostrum with low agglutinin and high hemolysin titers were more severely affected than those nursing colostrum with high agglutinin and low hemolysin titers. Experimental injections of serum or plasma from isoimmune mares into susceptible foals indicate that the rapidity of attack, lowering of cell count, severity of symptoms, and time required for recovery are all related to the intensity of reaction of the foal's cells with the serum in-vitro agglutination and hemolysin tests.

Passive immunity in new-born foals.—To determine the source of antibody passively transferred from the dam to the foal, five pregnant mares were immunized with *Salmonella abortus-equi* antigen. The mares received subcutaneous and intravenous injections until agglutinin titers of 1:5,000 or higher were obtained. In each mare the colostrum collected shortly after the mare foaled had a higher titer than the serum, in general 1:5,000 for the serum and 1:10,000 for the colostrum. Before nursing, the foals had serum titers of less than 1:100, the lowest dilution tested. Twelve hours after the foals nursed the titers of the foal serums against *S. abortus equi* antigen were 1:1,000; at 1 week, 1:500; at 1 month, 1:500; and at 6 months, less than 1:100. Titers of colostrum from the mares dropped from 1:10,000 to 1:200 within 12 hours after the foal began nursing. The mare milk had titers of 1:100 two weeks after foaling. The absence of *S. abortus-equi* agglutinins in the foal serums before nursing indicate that there was no transfer of antibody to the foal in utero. Passively transferred antibody is acquired by the new-born foal from the colostrum.

Nine foals were fed serum having a titer of 1:10,000 against *S. abortus-equi* antigen. Each foal received 1,000 ml at a single feeding by stomach tube. Before feeding the serum, it was determined that neither the mares nor foals had agglutinins in their serum against *S. abortus-equi*. At 12 and 24 hours following forced feeding of the serum, 3 foals that were fed at less than 12 hours old showed titers of 1:200 against the test antigen. Two foals, fed serum between the age of 12 and 24 hours, developed titers of 1:50 and 1:100 respectively. Three foals receiving serum between 24 and 36 hours old, and 1 foal 72 hours old acquired no agglutinins for *S. abortus-equi*. The results indicated that foals lose the ability to absorb significant amounts of antibody from the alimentary tract at approximately 36 hours of age.

Serum levels of penicillin in horses.—Using procaine penicillin in oil with 2 percent aluminum monostearate in doses of 1,000 units per pound, intramuscular injection resulted in serum levels having a duration of 8 hours in 7 of 8 trials. The quantity of penicillin in the serum varied from 0.04 to 0.16 unit per milliliter at 1 hour after injection. At 8 hours the measurable levels ranged from 0.04 to 0.08 unit/ml. No detectable quantity (0.01 unit/0.5 ml serum) was found at 8-hour sampling periods from the 16th to 48th hours inclusive. With doses of 2,000 units per pound, a measurable quantity of penicillin was present in the serum at 8 hours after injection in 3 trials, at 16 hours in 2 trials, 32 hours in 1 trial, and 48 hours in 1 trial. The serum concentrations ranged from 0.08 to 0.64 unit/ml at 1 hour after injection, from 0.04 to 0.32 unit/ml at 8 hours, and from 0 to 0.08 unit/ml for 8-hour sampling periods from the 16th to 48th hours.

A catalog of parasites of Kentucky horses.—Cataloging of parasites of horses was begun in 1947. A total of 15 genera and 26 species have been recorded as follows: tapeworms, *Anoplocephala perfoliata*, *A. magna*; roundworms, *Parascaris equorum*, *Oxyuris equi*, *Setaria equina*, *Strongylus edentatus*, *S. equinus*, *S. vulgaris*, *Triodontophorus brevicauda*, *T. tenuicollis*, *Gyalocephalus capitatus*, *Cylichodontophorus bicoronatus*, *Cyathostomum labratum*, *C. labiatum*,

Cylicocyclus nassatus, *C. insigne*, *Cylincocercus catinatus*, *Cylicostephanus* sp. (3), *C. poculatus*, *C. hybridus*, *Habronema muscae*; arthropods, *Otobius megini*, *Gastrophilus intestinalis*, *G. nasalis*.

Development of worm parasite infections in Thoroughbred foals.—A study of the occurrence, development, and methods of control of worm parasites of Thoroughbreds at representative horse farms in central Kentucky was begun in 1948. At present detailed studies have been made with 85 mares, 85 sucklings, 110 weanlings, and 103 yearlings from 12 different farms. The horse ascaris, *Parascaris equorum*, and the bloodworm, *Strongylus vulgaris*, have been established as the two most injurious worm parasites of horses.

The first source of ascaris infection for sucklings was found to be contamination which survived winter on paddocks and pastures first used by the new-born foals. A cycle of infection in the foals as weanlings was derived from their own earlier infection, and infections in yearlings. The ultimate source of bloodworm infection for new-born foals, however, was found to be the concurrent infections of their own dams.

Control and prevention of worm infection in foals was found to be absolutely dependent upon efficient and timely use of anthelmintic treatment. Most effective ascaris control was accomplished by a series of therapeutic treatments with carbon bisulfide, the first treatment being timed to coincide as closely as possible with the first maturity of infection. A system of low-level phenothiazine therapy, which prevented mares from sustaining seasonal increase of worm burdens, resulted in pastures less contaminated with infective worm stages and the consequent prevention of heavy infection of foals.

Continuous administration of phenothiazine to horses.—Four groups of three horses each were given low-level amounts of phenothiazine daily, beginning on April 28, 1948. The 1st group received 0.5 gram daily; the 2nd, 1.0 gram daily; the 3rd, 2.0 grams daily; and the 4th, 4.0 grams daily. The phenothiazine powder was fed on the grain ration. None of the animals gave evidence of any adverse effects from the treatments at any time during the 20 months of the test. At the end of the 1st year of the test one horse from each of the four groups was sacrificed for postmortem examination, to discover the remaining parasitic infection and any cumulative injurious effects of the treatment. There was found a direct relation between the amount of phenothiazine fed and both the reduction of strongyle infection and the prevention of reinfection. This finding confirmed previous evidence obtained by counts of worm eggs passed in the feces of the animals. A relation also was found between amounts of phenothiazine fed and the fertility of worm eggs passed by the horses. A significant reduction in numbers of immature *Strongylus vulgaris*, bloodworms, was found to have occurred in the anterior mesenteric arteries.

Worm parasite infections in Thoroughbred yearlings.—The incidence and development of worm parasites in 63 yearlings from eight representative Thoroughbred farms was studied in 1949. Incidence of infection and apparent total worm burdens were conditioned by methods of worm control employed at the individual farms. None of the 63 yearlings in the survey escaped injury due to parasite in-

fection. Unless prevented by anthelmintic treatment, the total parasitic infections increased progressively with the development of warmer weather in spring and early summer. Ascaris and strongyle infections remained as dangerous for the yearlings as they were for the same animals as sucklings and weanlings. The ultimate sources of parasitic infection for yearlings were their own concurrent infection and previous infection as weanlings. No methods of animal management or hygienic practice in use at the eight farms were sufficient in themselves to control worm infections. Control of worm infections was absolutely dependent upon efficient use of anthelmintics. The season when anthelmintics were administered and the method of administration were of equal importance with the amount of the anthelmintic used in treatment.

Treatment of bloodworms (immature *Strongylus vulgaris*) of horses in situ.— Newly developed filaricides are being tested for possible activity against bloodworms in the anterior mesenteric artery of horses. Courses of 15 consecutive intravenous injections of 100 cc of arsenamide sodium (trade name, caparside), 10 mg/cc, administered at 24-hour intervals to two yearlings and two 2-year-olds, did not result in apparent action against bloodworms as determined by postmortem examinations.

Blood samples of the four horses examined before, during, and after treatment demonstrated only progressive rises in white cell counts. These increased numbers of white blood cells were found to be related to inadvertent delivery of small amounts of arsenamide sodium into the musculature of the neck at the site of injection. Massive fibrotic areas developed at the site of one incorrect injection.

Methylbenzene (toluene) for ascariasis in horses.— Preliminary tolerance trials were made with three mature mares, one 2-year-old colt, three yearlings, and four weanlings to establish toxicity and possible action of methylbenzene against adult ascaris in the small intestine. Doses of 1cc/lb were well tolerated.

A series of 10 critical tests have established an apparent minimum dosage at 40 cc for effective ascaricidal action. Above the apparent minimum effective level, action of the drug in three critical tests was 100 percent effective. In a series of four dilution egg count tests, apparent 100 percent efficiency was also obtained.

Lipid content of various helminths of domestic animals.— In the preparation of lipid-free antigens of various parasites of domestic animals, the following lipid content in percentages of the total dry weights were obtained: *Moniezia expansa* (sheep tapeworm) 30.0 percent, *Anoplocephala perfoliata* (horse tapeworm) 31.0 percent, *Parascaris equorum* (horse ascarid) 9.0 percent, *Ascaridia galli* (chicken ascarid) 20.0 percent, *Strongylus vulgaris* (from an aneurysm in a horse) 11.0 percent.

Agglutination studies of *Clostridium* cultures.— Large-tube broth cultures containing 50 ml of horse meat infusion broth and 1.0 ml of a sterile 20-percent sodium thioglycolate solution were found to produce excellent growth of anaerobes for antigenic purposes. Serums

prepared by rabbit injection of this broth culture were obtained for cultures of *Clostridium tetani*, *C. botulinum*, *C. oedematiens*, *C. sporogenes*, *C. histolyticum*, and 2 cultures of *C. welchii*.

Agglutination of somatic "O" and flagellar "H" antigens was carried out according to the procedure used in *Salmonella* typing. "H" antigens of the motile *Clostridium* organisms were quite species specific, and homologous serums gave titers of 1:2,000. Cross reactions occurred in agglutination studies of the "O" antigen.

At a dilution of 1:100, somatic "O" relationships were found between *C. tetani* and *C. histolyticum*; *C. histolyticum*, *C. tetani*, and *C. welchii*; *C. welchii* and *C. histolyticum*; *C. sporogenes* and *C. oedematiens*.

***Salmonella* and paracolon bacteria.**—A total of 764 cultures of enteric bacteria were examined in 1949. Of these cultures, 110 were isolated from man, 653 from animals, and 1 from a food product. Classification of the 764 strains showed 579 strains of *Salmonella*, 25 strains of Arizona paracolons, 2 strains of Bethesda paracolons, 4 strains of Ballerup paracolons, and 154 strains of other bacteria.

Four new *Salmonella* types were identified: *S. donna* (XXX, I,v-1,5), *S. weslaco* (XLII:z₃₆), *S. macallen* (III,X:z₃₆), and *S. canoga* [(III), (XV), XXXIV:g,s,t]. In addition, the identities of 7 new *Salmonella* types were confirmed for other laboratories.

Studies on induced variation were continued and it was found that it was possible to change the H antigen of *S. oranienburg* (VI,VII:m,t) to a form indistinguishable from the H antigen of *S. monteideo* (VI,VII:g,m,s). This transformation was not simply a loss variation, for although antigen t was lost, antigens g and s were gained and m was retained in a recognizable state.

A group of 47 cultures were studied and classified as the Ballerup group of paracolon bacteria. Members of this group are directly or indirectly related to an organism formerly known as *Salmonella ballerup*. Antigenic study revealed 17 flagella antigens of diagnostic significance, and 3 somatic groups, one of which is divisible into 5 subgroups. Twenty-one serological types were delineated. Nineteen cultures possessed the Vi antigen. Most of these cultures were derived from asymptomatic human carriers, but at least 13 were associated with human gastro-enteritis.

Three monophasic *Salmonella* cultures were received which had the formulae: VI,VII:y; XXVIII:y and III,XV:z₁₀. These were successfully used in production of agglutinating serum for serological typing of *Salmonella* strains.

Formula price of fluid milk.—To test the application of formula pricing of fluid milk under Kentucky conditions, the Boston formula which substitutes mechanical computations and economic indexes of quotations on manufactured products for negotiations between producers and distributors was applied to local data for the Louisville area and the results computed. Use of the formula would have resulted in a price about equal to the prevailing one during 1925-31, but in 1932-42 the price would have been consistently lower than the actual Class I price. The period 1943-48 proved difficult to analyze, because of war restrictions on supply and demand, and the abnormal situations.

In general, the calculated price was lower than the actual price in the early stages, and above the actual price in the last three years. No one can say exactly what the situation would have been if the formula prices had prevailed, but unless supply and demand would have been markedly different, the formula, as proposed, would not have worked well for Louisville. Over the period, and with the same volume of sales, producers would have received over 2.5 million dollars less than they actually realized.

It was clearly evident from this study that it would be unwise to assume that a formula, in this case the Boston formula, could be applied without modification to Louisville or other markets of similar character.

Marketing veal calves by carcass weight and grade.—The major emphasis in this investigation was given to an analysis of the relative accuracy with which calves are purchased under the present live-weight method.

Data were obtained on 419 veal calves purchased by a Kentucky packing plant. An experienced packer-buyer estimated the dressing yield and the carcass grade for each animal on the hoof. The actual yield was obtained by dividing carcass weight by live weight and the actual grade was assigned to each carcass by federal meat graders. The divergence between the estimated and actual yield and grade defines the limits of the buyers' ability to accurately arrive at price. The buyer correctly estimated the yield of 10 percent of the calves. On the remaining 90 percent the over-estimates tended to balance the under-estimates. To a lesser degree the same condition existed in the estimates of carcass grades. The buyer correctly estimated the carcass grade of 62 percent of the calves, over-estimated 18 percent, and under-estimated 20 percent.

These figures indicate that it is extremely difficult for even an experienced packer-buyer to estimate correctly the dressing yields and carcass grades of veal calves. Although the estimates for yields and carcass grades of the entire lot of calves were fairly accurate, the fact remains that the owners of 90 percent of the calves were not exactly remunerated for the actual dressing yields of their animals. Likewise, the owners of 38 percent of the calves were not exactly remunerated for the actual carcass grades of their animals.

Seasonal variation of prices and receipts of feeder pigs.—Prices of feeder pigs in central Kentucky typically rise seasonally from the beginning of the year at a steady rate through June and climb sharply in July to a peak for the year at 110 percent of the season's average. After a decline in August, prices of feeders remain at about the same level until distinct drops occur in October and November and the low for the year is reached in December, at 90 percent of the average for the season.

Prices of light-weight feeder pigs (under 80 pounds) and of medium-weights (80-119 pounds) rise from the beginning of the year to a plateau during May, June, and July, prices for May being slightly higher than for the other two months. For heavy-weight feeder pigs, there is a closer relationship to prices of slaughter hogs with the secondary peak in prices in March, characteristic of slaughter hog

prices, and a main peak in July. All the differences of note in the three seasonal price patterns appear between March and September.

Receipts of feeder pigs on the Kentucky auction markets show much greater seasonal variation than prices. On the average, feeder-pig receipts decline from the beginning of the year through March, rise slightly in April and May, reach a low for the year in June, rise steadily and rapidly to a peak in October, and decline during the remainder of the year.

Receipts of light-weight feeder pigs typically are lowest in May, and medium-weights are lowest in June. Receipts of heavy-weights are usually lowest in February, with a secondary low in July. In this respect receipts of the heavy-weight group more nearly approximate the seasonal movement of receipts of slaughter-weight hogs. Peak receipts for light-weight feeders and medium-weights usually occur in October on the Kentucky auction markets, while heavy-weight feeders typically reach peak receipts in November, with a secondary peak in May.

Consumer preference for sweet corn or green field corn.—Regular white field corn, harvested in the milk stage, has for many years been sold on the Louisville fresh vegetable market as green corn. Little, if any, sweet corn has been sold on that market. Sweet corn is a highly perishable commodity as its quality, sweetness, and tenderness of kernel rapidly deteriorate after harvest when exposed to temperatures above 50° F.

A study was made in the summer of 1949 involving (1) method of harvesting and handling sweet corn so as to maintain quality and (2) consumer reaction to good quality sweet corn as compared with the regular green field corn. To maintain quality of sweet corn, three methods of harvesting and handling were tried. First, sweet corn was harvested early in the morning, delivered direct to retail stores before 9:00 A.M., placed under refrigeration, and displayed for sale on refrigerated racks. Second, sweet corn was harvested in the afternoon, drenched with ice water, rushed to a warehouse and refrigerated at 38° F until the field heat was withdrawn, distributed to retail stores, refrigerated again, and displayed for sale on refrigerated racks. Third, sweet corn was harvested in the afternoon, placed in ice water for 20 to 30 minutes, packed in bushel baskets with crushed ice and held on the farm until morning, delivered direct to the retail stores, refrigerated, and displayed for sale on refrigerated racks. There was no apparent difference in quality of corn handled in these ways.

To discover consumer preference of sweet corn so handled or of green field corn handled in the customary manner, 1,632 purchasers were interviewed in the six Louisville stores where the corn was handled during a 4-week period. Sweet corn was sold for 5 cents per ear and the field corn at 3 ears for 10 cents. Consumers bought 67 percent sweet corn and 33 percent field corn. Consumers who bought sweet corn gave as their reasons that it was better flavored, sweeter, more tender and juicy, richer in vitamins, and better in quality. Those who bought field corn gave as their reasons that it was better to cut off cob, better in flavor, had smaller kernels, was more tender, that they did not like yellow corn, that the ears were larger, and that

the field corn was more economical. Resales were checked the third and fourth week to find out whether consumers changed from one variety to the other. Eighty-four percent repurchased the same variety purchased previously, 12 percent changed from sweet corn to the field corn and 4 percent changed from the field to sweet corn. Change from sweet corn to field corn was due primarily to a lowering of the quality of the sweet corn caused by worm damage. More than 70 percent stated they purchased corn more often when the sweet corn was available.

Marketing western Kentucky pink-ripe tomatoes.—Pink-ripe tomatoes from western Kentucky sold at premium prices during July and early August in large terminal markets to the north and east. Such premiums were due to (a) the high quality of the tomatoes, (b) attractiveness and durability of the 10-pound cardboard basket used, (c) reduced labor and storage requirements in terminal markets, and (d) the elimination of losses which terminal markets had experienced when mature-green tomatoes were held for ripening.

Pink-ripe tomatoes had to be handled more carefully than mature green tomatoes during preparation for market. It was found that machinery ordinarily used during preparation for shipment could be eliminated and the 10-pound baskets packed directly from field crates. It was also found that only about half the tomatoes produced in a normal season meet the rigid requirements of market for pink-ripe fresh tomatoes, and that consequently secondary outlets, such as truckers to handle the slightly "off grade" or No. 2 tomatoes and a contract with a cannery to utilize the cannery grade tomatoes, are necessary to the success of marketing pink-ripe tomatoes.

Tomatoes too green upon arrival at northern cities brought prices much lower than those reaching the market in the desired stage of color. Only tomatoes showing from a third to a half pink color were adapted to shipment and only those showing the same extent of coloring should be packed in any individual package.

Production of an earlier variety, or use of different cultural practices so as to market tomatoes 10 days to 2 weeks earlier, when prices are usually much higher, would have been profitable.

Amount of use and unit costs of field choppers and self-tying balers on farms.—A survey of roughage-harvesting field choppers on 25 farms emphasized the importance of adequate use in lowering the unit cost. Field choppers harvesting an average of 70 tons annually had a total cost of \$6.25 per ton (labor, fuel, and machine cost) for cutting, raking, and placing in the mow; 140 tons annually averaged \$5.01 per ton; 230 tons annually, \$3.87 per ton; and over 504 tons annually, \$3.47 per ton.

A study of 12 self-tying hay balers also indicated a reduction of cost with increased annual use: \$8.75 per ton for 85 tons baled annually; \$6.79 per ton for 119 tons baled annually; \$4.92 per ton for 245 tons annually; and \$3.83 per ton for an average of 518 tons annually. The larger amount of labor required in handling the baled hay made the baling cost higher than field chopping.

For either of these machines considerable tonnage had to be harvested annually for a substantial reduction of unit cost. The an-

nual depreciation charge on such machines is large, and this causes the unit costs for harvesting a small annual tonnage to be high. Obsolescence of such machines, due to change in design, has a material influence upon depreciation.

Returns to labor and capital used to develop pasture from woodland in the Eden Shale Area.—Bluegrass pasture developed from woodland slopes on a group of farms in the Eden Shale portions of Scott, Grant, and Pendleton counties yielded an average of 545 pounds of TDN when grazed by dairy cattle. The pastures were chosen to represent the usual hill pastures in this area with slopes of 20 to 30 percent. The yield of 545 pounds of TDN per acre represents the calculated amount consumed by dairy cattle under ordinary farm stocking rates and pasture management. Typically, much of the lush spring growth is under-utilized because of the practice of stocking somewhat according to carrying capacity during late summer and early fall. Four to 5 acres of pasture were required to carry one dairy cow. This would supply about half the annual TDN requirements of a 1,000-pound cow producing 5,000 pounds of milk. Twenty to 25 acres of the usual woodland pasture in this area would be required to supply the same amount of nutrients.

Using average prices for the period 1947 through 1949, the value of additional livestock products produced per acre of reclaimed pasture on this group of farms would be about \$22.00. Net returns to land and labor would pay 5 percent on the investment in land reclamation and leave four to five dollars per day for the labor required to maintain pastures and care for the livestock.

Such returns from reclaimed pasture under usual management would not seem to justify clearing woodland needed to supply the farm with fence posts, fuel wood, and saw timber. However, many farms in the area have much more brushland and low-grade woodland than is needed for fuel wood, and much of it is not potentially suitable for the production of either posts or saw timber. The conversion of this low-grade brushland to pasture will increase cash farm income appreciably on many farms in this area, but the returns per day of labor required to maintain pastures and care for livestock will be rather low.

Stands and sites of farm woodlands in the Eastern Pennyroyal Area.—Reconnaissance of woodlands in the uplands of the Eastern Pennyroyal Area of Kentucky indicated that about 90 percent are understocked as a result of excessive and nonselective cuttings in past years. The virgin forests had a volume of saw timber ranging from 6,000 board feet per acre on the dry ridges to 20,000 or more board feet on the best sites. At present about two-thirds of the woodland has less than 2,000 board feet per acre, and 30 years or more of good management would be required to convert these tracts to a reasonable sustained-yield level of saw timber. The remaining one-third could be put on a sustained yield of 200 to 400 board feet per acre per year within 20 years.

About 15 percent of the woodland is either so badly depleted or has a stand of such low value species as to be worthless for quality timber production within the time span of three generations or more of farmers. Most of this land is suitable for permanent pasture or rotation

cropland. Another 15 to 20 percent is marginal for use as woodland, and serious consideration should be given to clearing and converting to pasture or cropland. The remaining 65 to 70 percent of the woodland is too steep or soil quality too low for any crop other than trees, or the stand is adequately stocked for good returns in timber production, and the major consideration is not whether to clear for cropland, but to apply timber management practices that will be most profitable.

Costs and income in farm production in the Bluegrass Area.—Cash receipts in 1948 were higher than in any other year of the period 1930-48, averaging \$2,813 for small farms, \$4,462 for medium-sized farms, \$7,103 for large farms, and \$5,043 for the area. Because of higher prices and increases in production of tobacco and livestock, cash receipts rose greatly during the period. For all three sizes of farms two-thirds of the cash receipts were from burley tobacco and most of the remaining third was from livestock. On the small and medium-sized farms, sales of milk and eggs were more important in relation to sales of other livestock than they were on the larger farms. Prior to 1941 a smaller proportion of the cash receipts were from tobacco.

Cash farm expenditures were also higher in 1948 than in any other year. The upward trend in expenditures were principally because of increases in use of fertilizer and bought seeds, higher labor requirements per farm, and greatly increased prices of practically all cost items. Cash expenditures averaged \$2,154 for the area-type farms in 1948, or 42.7 percent of the average cash receipts.

The amount of cash available for the personal use of the farm operator and his family after payment of actual rent costs and interest on farm mortgage debts averaged \$1,797 for small farms, \$2,252 for medium-sized farms and \$3,192 for large farms in 1948. These net cash incomes were the highest for the period.

Net farm incomes (including value of perquisites and allowances for changes in inventory values from year to year) averaged \$2,583 for small farms, \$3,391 for medium-sized farms, and \$4,789 for large farms, in 1948.

Farmland values and trends.—Sales of farmland in Kentucky declined in 1949, a continuation of the decline which began in 1947. The volume of sales in 1948 was 15 percent below the peak year 1946. For four representative counties in Kentucky farm sales in the peak year 1946 were only 58 percent of the number of sales for 1919, the previous peak year.

Prices received for farmland continued to increase in 1949, although at a slower rate than in the period 1944-46. For the four counties, farmland prices in 1948 were 84 percent higher than the average prices in 1941, but 8.5 percent less than the average for these counties in 1920, the peak year of land prices.

About three-fifths of all sales of farmland in 1948 were for cash, about the same ratio as in recent years. This was in sharp contrast to the period 1917-20, when a high proportion of the sales of farmland were cash-credit transactions. For the credit-financed sales in 1948 the mortgage debt averaged 59 percent of the purchase price. Average mortgage debt per acre has been gradually increasing, paralleling the increase in sales value per acre.

In 1945, three-fourths of the mortgage-financed sales were for five years or less, and in 1948 only two-fifths of the mortgages were in this group. For mortgage-financed sales in 1948, 50 percent of the mortgages were held by the persons selling the land. Individual lenders constituted about two-thirds of the various sources of credit in 1948, and about one-third in 1941. Most of the farm buyers were owner-operators or tenants; most of the sellers were farmers and administrators of farm estates.

More farmers than ever before now own part or all of their farmland, and there are fewer tenants than at any time in the past 25 years. Total mortgage debt of farm owners reached in 1946 the lowest figure since 1919; since 1946 it has increased slightly, about 9 percent.

Production rates on successful farms.—Financial, crop, and livestock production records were obtained and analyzed for successful farms of different sizes in different areas of the state. These farms had yields of around 2,000 pounds of burley tobacco and gross incomes of \$900 to \$1,000 per acre of tobacco, 50 or more bushels of corn, 2 tons or more of legume hay, and a high proportion of farmland used for hay and productive pasture. To attain these production rates it is frequently desirable and profitable to spend \$5 to \$10 per acre of crops for limestone and the fertilizers required to supply the plant food elements deficient in many soils. Expenditures for burley tobacco fertilizer and green manure crops usually range from \$15 to \$40 or more per acre on successful farms. Livestock production is higher than average on these farms.

On many large farms the gross receipts exceeded \$100 per acre and on farms of typical size, averaging about 100 acres, the receipts were frequently considerably more than this amount.

Contrasts between outstanding and typical small farms in six south-central counties.—On 12 outstanding small farms, having less than 40 acres of cropland and averaging 32 acres per farm, the total farm receipts and operator's net earnings were fairly consistent during the period 1946-48, averaging each year about \$100 per acre of cropland and \$1,723 net earnings per farm operator (return after paying farm operating expenses and deducting interest at 5 percent on an average investment of \$8,115 in land, buildings, livestock, machinery, and equipment). The outstanding farms were outstanding mainly in organization and management, which was reflected in production, receipts, and net earnings.

Average yield of tobacco on the 12 farms in 1946 was 1,803 pounds per acre, approximately 50 percent more than the average on 105 typical farms. Corn yields on the 12 outstanding farms averaged 48 bushels per acre, 25 percent higher than on the typical farms. Total farm receipts and farm earnings for the outstanding farms (\$101.16 per acre of cropland in 1946) were more than double those of the typical farms. Net earnings of the operators of the outstanding farms were three times as much as for the typical farms, not including incomes from off-farm employment. When income from off-farm employment is included, the operator's net earnings on the outstanding farms were nearly twice as great as those on the typical small farms.

The outstanding small farms had 25 percent more dairy cows than the typical small farms and more than twice as many chickens.

Patterns of rural social organization in Kentucky.— In a study of organizations in four counties representing different social subregions, much variation was found in number, variety, and nature of group organizations, and a progressive pattern of variation was revealed which appears to illustrate different stages in the change toward greater diversity and complexity. A representative Mountain county (Magoffin) had a total of only 46 organizations, exclusive of institutionalized organizations such as churches, schools, and local government, as contrasted with over 187 in a Bluegrass county (Harrison) of slightly less total population. The counties with fewest organizations were the most rural; had lower average incomes per family; had higher proportions of children in the total population; were characterized by subsistence farming; had fewer homes with electricity, telephones, radios; and had poorer roads and fewer automobiles.

Organizations in the most rural county (Magoffin) were on the average more recently organized; were composed primarily of youth; were more likely to have been motivated by forces from outside the county; were less likely to have charters, constitutions, and other evidences of formality in their structures; were comprised primarily of members who live on farms or out in the country; and met less frequently during the year. In the more rural counties the function or interest of a higher percentage of organizations centered around farm and home improvement, school activities, and youth activities, while in the less rural counties the organizations were predominantly for brotherhood and fraternal interests, benevolence and welfare, recreation, hobbies and sociability, and business and community improvement. Organizations consisting primarily of men constituted a larger proportion of all organizations in the Mountain and Plateau-Margin counties (Magoffin and Powell) than in the Bluegrass county (Harrison) or in the Pennyroyal county (Logan).

Prestige ranking of organizations.— Officers or leaders in organizations studied were asked to rank all the organizations in their county with which they were familiar, according to their estimate of the organization's standing in the community. In the Bluegrass county (Harrison) women officers and leaders tended to rank women's organizations highest, and men officers tended even more to rate men's organizations highest. In the Mountain county (Magoffin) although women on the whole placed their organizations high on the list they tended to agree with the men in ranking men's organizations at the top.

In general, organizations with a broad purpose and those serving the whole community or a large part of it were given the highest rank, and organizations with limited purposes and involving fewer people with more special interests were given the lowest rank. The higher ranking organizations were generally better known and on the average had larger memberships, more units per county, more regular attendance at meetings, more officers and committees, and more extensive intercounty connections.

Size of rural social organizations.— A study of the size of rural social organizations revealed that the smaller organizations (under 40 members) were more recent in origin; were less likely to have

charters, constitutions, and other formal documents; and were more likely to have as their purpose recreation, sociability, or advancement of church activities than business improvement, welfare, social action involving the whole community, or the advancement of school interests. Also they were composed primarily of women; had younger members; had more stable memberships; and had much higher percentage of the membership in regular attendance at meetings. Men's organizations were larger than women's organizations.

Opportunities for social contact between town and country in rural social organizations.— Of 497 organizations studied, 316 or approximately 64 percent were organizations whose membership included both town and country people. Organizations such as lodges, P. T. A.'s, and veterans' organizations had the broadest membership and usually included both town and country members. Joint organizations were larger (average membership 52) than organizations with only country members (23) or organizations with only town members (17). Although people living in the country have opportunity to meet with town people in joint organizations, their participation in the activities of these organizations was not proportional to their membership. They held fewer of the offices and attended meetings less frequently.

Changes in returned migrants.— In a study of three magisterial districts (Graves No. 3, Magoffin No. 1, and Scott No. 3) in 1947, interviews were held with a random sample of men and women who had left their local residence, had remained in other places for at least one year during the war and postwar period, and who had then returned. These returned migrants reported changes in their social participation, economic situation, and viewpoints on farming, education, community matters, and various public issues. The returning migrants introduced into their communities a new variety in opinion and viewpoint. The returnees were less inclined to be indifferent toward community issues than they had been before. The influence of migration was about the same for civilian and for military experience during the period of absence from the community.

Population changes in Magisterial District No. 3 of Powell county.— The population of district No. 3 of Powell county declined from 2,068 to 1,987 (or 4 percent) from April 1940 to June 1948. Since Stanton, the county seat, gained slightly in population, the decrease was due to migration from the open country. With the gradual return of war workers and veterans and the influx of people from other parts of Powell county and nearby counties, this district's population may reach the 1940 level in the next year or two.

Of the district's population 15 years of age and over, 22 percent had not been living in the district in 1942 but had moved there by 1948, and an additional 13 percent of those aged 15 and over had been living in the district in 1942 but had lived outside of it six months or more since the beginning of the war and had returned by June 1948.

More than a third of the people who came into the district for the first time since 1942 came from other parts of Powell county (38 percent); another third came from other Kentucky counties (36 per-

cent), mainly from adjacent counties; 18 percent came from other states; and 8 percent came from the armed forces. Most of these people had been in nonfarm activities before they moved into the district and had moved into the district since the end of the war. There was some indication that the rate of influx was increasing.

Mountain families on small farms.—An intensive study was made of families living on small farms in an isolated Mountain neighborhood. The farming was small-scale, subsistence farming. More than two-thirds of the total value of farm products produced by thirty families consisted of farm products used at home. Of cash income only 25 percent came from sale of farm products; 75 percent came from nonfarm sources. Nearly a third of the cash income of these families came from the U. S. government. The farms had become less and less productive though the number of people dependent upon them had steadily increased. Agriculture had increasingly become part-time farming.

The family was the main unit of production and of consumption, and family controls were the main economic controls. The daily, weekly, and seasonal activities of the families were very similar. The family members all had their roles in the farm work, depending on age and sex. The economic roles of the people in the neighborhood were in large part inseparable from their roles as members of families. As nonfarm employment had become more important, the old daily and seasonal patterns of activities had changed.

Kinship structure and family groups in Mountain neighborhoods.—A study of three isolated neighborhoods in eastern Kentucky showed the extent and importance of kinship. Of the total number of possible single, closest relationships among the 38 families of one neighborhood, nearly 20 percent were relationships of parents and children, siblings, aunts or uncles, nieces or nephews, grandparents and grandchildren, or first cousins. An additional 24 percent were relationships of first cousins once removed or second cousins. "Family groups" (the families of old parents and their adult children or the families of adult siblings) were social groups of great importance. Family groups were somewhat more likely to be constituted of the husbands' than of the wives' kin. They were often territorial groups, and almost always family-group members had their closest and most frequent visiting relationships within the group. Crises such as death and sickness were met by this broader group. Such groups had leadership structures and mechanisms for settling disputes among their members. The extensiveness and the closeness of kinship ties had much to do with the solidarity of the neighborhoods. One reason for the lack of "neighborhood feeling" and "community spirit" in these Mountain areas was that the familial groups — the conjugal family and the family groups — performed such a large share of the necessary functions in the society that neighborhoods and communities had relatively little reason for existence.

Creamery license section.—Licenses to buy milk or cream on butterfat basis issued and now in force total 968, of which 943 are renewals and 25 are for buying places beginning operation after

July 1. The total includes 6 creameries, 16 cheese plants, 10 condenseries, 89 milk plants and ice cream manufacturers, and 847 cream-buying stations. Authority to test for the period ending June 30, 1950, was issued to 1,088 operators of the Babcock test, including 877 renewal licenses, 76 licenses issued since July 1 following satisfactory examination, and 135 permits pending examination issued since July 1.

Examinations for applicants for license to test were held as follows: Bowling Green 2, Columbia 1, Lexington 2, Louisville 2, Mayfield 1, Maysville 1, Owensboro 1, Princeton 1, Somerset 1, special 19. Of 240 applicants notified to appear for examination 139 appeared, 127 passed, and 7 failed.

Of 21,178 milk and cream test bottles, cream test weights, and milk pipettes received for calibration, 12 were rejected. Items of operating equipment in use found on inspection to be incorrect or defective and possible cause of inaccurate weights or tests were: 4 test scales, 42 cream test weights, 2 receiving scales, 1 centrifuge, 2 pairs dividers, 4 thermometers, 68 pieces illegal glassware, 19 pieces miscellaneous equipment. These were condemned and ordered to be replaced.

During the year 811 inspections of buying places were made, including 23,420 Babcock tests of milk and cream. On basis of these inspections operators were graded as follows: A and B (satisfactory) 438, C (unsatisfactory) 274, D (probation) 81, E (cited to appear before Examining Board) 18.

The Examining Board disposed of 20 cases of operators cited to appear before it because of unsatisfactory inspections and violations of regulations as follows: 11 licenses and 2 permits revoked, 6 operators placed on probation with a decision to be based on future inspections, 1 operator removed from probation and placed in good standing.

Receipts for the year from station licenses were \$5,855.50; from testers' licenses \$2,360.50; and from glassware, \$686.83; total, \$8,902.83.

Nursery Inspection.—During the past few years an unusual interest in boxwoods developed in a few centers in Kentucky. As a result haulers began collecting these plants from old estates and other places in North Carolina. Much of this material was not inspected even though it came from areas infested by Japanese beetles.

Realizing the potential dangers of importing this pest in the soil balls around the plants, the Kentucky Entomologist requested and obtained, in May 1949, from the Bureau of Entomology and Plant Quarantine the loan of 100 Japanese beetle traps. These traps were located in the areas where imported boxwoods had been planted during the past two or three years. The Kentucky State Nursery Inspector operated the traps for a period of 10 weeks beginning June 6. In early July, 7 beetles were caught in the traps located in two nurseries at Shively, Kentucky. After the first beetles were taken, additional traps were placed in the area to delimit the infested territory. With the exception of one beetle found in Covington by a representative of the Bureau of Entomology and Plant Quarantine, the Shively infestation was the only one found in the state this year.

As soon as the beetles were discovered, all plants in both nurseries involved were sprayed with DDT, the soil was treated with the same

insecticide, and all balled and potted plants were dipped, under the supervision of the nursery inspector, in the government recommended ethylene dibromide-chlordane solution.

During the regular inspection season 92 inspections were made of growing nursery stock, including 64 inspections of general nursery stock, 7 of fruit stock only, 3 of strawberry plantings, 3 of sweet potato plant beds, 12 of bulbs and perennials, and 3 of greenhouses. In these examinations the following insects and plant diseases were found and are recorded in the order of their frequency of occurrence. *Insects*: Bagworm, white pine cottony aphids, oriental fruit moth, grasshopper, iris borer, holly leaf miner, and pine needle scale. *Diseases*: Brown Felt's rust (white pine), peony blotch, iris leafspot, cherry leafspot, and powdery mildew (apple and lilac).

Red spider, for the second year in succession, was the most prevalent and most important pest in the nurseries. It appeared in great numbers and caused noticeable damage in practically every planted area in the state.

Seed inspection.— During the year 11,307 samples of seed were tested, of which 683 were official samples taken by inspectors from the stock of wholesale and retail merchants. The remaining samples, sent to the laboratory by seedsmen, farmers, and others, included 4,834 samples of grass seed, 3,286 of legume seed, 1,698 of cereals, 458 of tobacco seed, 346 of vegetable seed, 28 of hemp seed, 6 of cotton seed, 5 of rape seed, and 13 seeds for identification. Tobacco seed cleaned during the year amounted to 3,094 pounds. Fescue samples again this year outnumbered all other varieties of seed tested.

Fertilizer control.— The number of fertilizer samples analyzed and reported has been increasing each year, from 601 samples in 1943 to 1,963 samples this year. Fertilizer inspections totaled 3,740 this year, about 1,400 more than in 1948. Reported shipments without labels totaled 163, a somewhat higher proportion than in 1948. For these shipments not labeled, tags were received later by the dealers from the manufacturers.

Of all the fertilizer inspected, 59 percent met guarantee in all respects, or was better than the guaranty. The corresponding figure for 1948 was 62 percent. Eighty-nine percent of all analyses were within $\frac{1}{4}$ of 1 percent of the guaranty, the tolerance allowed by law. Where a product was at considerable variance from the guaranty, it was either withdrawn from sale, retagged, or refund was made, depending upon the circumstances. Refunds were suggested when the relative value index per ton was \$1 or more below guarantee, or the nitrogen, available phosphoric acid, or potash \$1 or more low in value. Refunds were made payable to the purchasers of the fertilizers when they could be located from the dealer's records. Otherwise, refunds were paid by the manufacturers to the charity of their choice in the county where the fertilizer was sold, or to a charity of national significance. A total of 152 samples of fertilizer were sufficiently at variance from the guaranty to warrant payments of this kind or withdrawal from sale.

No cases were filed for prosecution during the year.

An investigation on sampling of fertilizers, and other collaborative work, was continued and the work reported to the Association of

Official Agricultural Chemists. Check samples and samples for dealers and farmers were also made.

License tags were issued for 501,330 tons of fertilizer, which was 9.3 percent under the all-time record for the year 1948.

Feed control.—The year was noteworthy in Kentucky for feed manufacturers and dealers and for progress in feed control work. The number of samples analyzed increased to 3,359 and the number of specific control services rendered otherwise expanded this year.

In previous years almost half of the samples collected were at variance from the guaranty in some significant respect. In 1949 only 32 percent were at variance. Eighty-three percent of the samples analyzed were within 0.5 percent (the tolerance allowed) of the guarantee in protein; 90 percent were within tolerance for fat and 96 percent for fiber. This was an improvement over 1948.

Improvement also was noted in the matter of adulterated feeds. In 1948, 10 percent were classified as adulterated, but in 1949 only 2 percent. Color photography was used this year in reporting microscopic examinations, leaving no doubt as to the kind of ingredients present in such cases. The technique for doing this has been worked out during the past two years at this Station.

Three cases involving interstate shipments were filed with the Food and Drug Administration. One of these was settled by the manufacturer agreeing to cease doing business in Kentucky. The other two are pending. Seven court cases were filed in Kentucky and are likewise pending.

Visits by inspectors to warehouses of feed dealers throughout the state totaled 9,200 during the year. On these visits, 620 shipments of feed were found untaged, about the same proportion as last year.

Special inspections of dog foods and mineral feeds were made. Weight checks were conducted at intervals.

Collaborative work with feed control officials in other states and with other departments of the Kentucky Station was continued. A total of 480 samples of a special nature were analyzed for cooperating groups including those sent in by manufacturers, dealers, and consumers.

License tags were issued for 617,700 tons of feedstuffs — slightly less than in 1948 but more than in 1947.

Soil-testing laboratory.—Soil testing in 1949 increased greatly continuing the upward trend of the past several years. Twenty-four of a total of 26 county soil-testing laboratories were established in 1949. These laboratories are using methods devised and approved by the Experiment Station and the same that have been used in the Station laboratory except that an indicator method is used for pH determinations instead of the glass electrode.

During the past year, soil tests for potassium have been run with the flame photometer on the same extract used for phosphorus. When a considerable number are to be run this is a much more rapid procedure and gives far more exact results than the quick-test method used formerly and that is still being used in county laboratories. The quick-test procedure for potassium usually gives results that correlate quite well with the more exact flame photometer method but in the

high or very high range the quick-test procedure does not seem to be quite as accurate. The sensitivity of this method reaches its limit at about 250 pounds per acre.

A total of 2,344 samples were analysed by the Experiment Station, including 1,569 samples tested for farmers, gardeners, and others, 375 for Experiment Station projects, 294 for other state institutions, and 106 to check on county laboratories.

Public service laboratories.—A total of 28,910 specimens were examined in the several divisions of the department, of which number 24,233 were for microscopical, cultural, or serological examination, 4,421 were for bacteriological and chemical examination of milk and other dairy products and miscellaneous foods, and 266 were of a widely different nature, consisting of drugs and drug products for composition and purity, toxicological examinations of human and animal stomachs and other organs for poison, food products for both animal and human use for poison, and of public and private water supplies for chemical analysis for composition and suitability for use.

During the year a total of 462 animal heads were received for examination for rabies, of which 228 or 51 percent proved positive for rabies. Of these positive heads, 153 were dogs, 22 cats, 17 cows, 4 steers, 3 calves, 3 hogs, 1 horse, 1 mule, and 1 lamb. Rabies is becoming quite prevalent among wild animals. Fourteen foxes, 2 squirrels, 3 skunks, 1 ground hog, and 1 rabbit were found during the year to be infected with rabies.

A total of 1,842 throat swabs were received for culture for diphtheria, scarlet fever, and septic sore throat, of which 107 proved positive for diphtheria and 134 positive for hemolytic streptococci.

Eight hundred fifty-six specimens of feces and urine were cultured for typhoid and other enteric disease organisms. Most of these specimens were from food handlers in dairies, restaurants, and other food establishments. *E. typhosus* was isolated from 19 specimens feces and from 7 specimens urine. Organisms of the *Salmonella* group were found in 3 specimens.

Microscopical examination of 1,075 specimens of sputum, concentrated by the flocculation method, showed the presence of acid-fast organisms identical with microbacterium tuberculosis in 204 specimens, or 18.9 percent of specimens examined. Cultures were made on 534 microscopically negative sputa and 25 were found positive for tubercle bacilli.

A total of 67 special investigations were made on miscellaneous food specimens submitted in connection with cases of suspected food poisoning. Such specimens consisted of raw and cooked meat products such as hamburger meat, souse, roast veal, chicken and ham, pastries such as chocolate eclairs and cream pie, milk and milk products, salads and similar products that had been allowed to stand for several hours without proper refrigeration.

A total of 31 different disinfectant and germicidal products were examined for germicidal potency and 2 were found to be deficient in germicidal effect.

Chemical examinations were made in the food laboratory of 4,251 dairy products of which 4,157 were milks, 50 creams, 13 chocolate milk drinks, and 12 ice creams. Fifty-nine samples of milk were found to

contain added water, ranging from 10 percent to a high of 63 percent in one case. The phosphatase test for efficiency of pasteurization was run on 1,557 samples of pasteurized milks and milk products and 25 were found to be underpasteurized.

One hundred and twenty-nine samples of water were examined for composition, suitability for domestic use or as a source of public water supply, and type of treatment needed, if any.

Chemical analysis was made of 20 samples of material submitted in connection with suspected poisoning of man or animals. Toxicological examination was made of autopsy material submitted by coroners in connection with the death of six persons. The stomach and intestinal contents from 32 animals were examined for poison during the year. Of this number strychnine was found to be the cause of death of 3 dogs, lead paint in the case of a steer, and water hemlock plant poisoning to have been responsible for the death of 3 cows, 1 sheep, 1 steer, and 2 calves.

A total of 4,038 specimens of water were received for bacteriological examination to determine if safe for use for drinking purposes. Of 1,726 samples of well water, 50.9 percent showed contamination; of 812 cisterns, 326 or 40 percent were contaminated; of 259 springs, 165 or 63.7 percent were contaminated. Of 1,002 samples of water from treated city supplies examined, only 57 or 5.7 percent showed evidence of sewage-type contamination.

WESTERN KENTUCKY SUBSTATION

General farm production.—Yields of field crops, pasture, and fruit were good again this year. Heavy rainfall throughout much of the year contributed to high yields but made farm management difficult. Excessive rainfall in January, February, and March prevented early preparation of land for crops. April and May were more favorable for getting out crops, but in June 6.09 inches of rain fell on 13 days, during which time little or no cultivation of crops could be done. In August, 5.91 inches of rainfall on 12 days was excessive for tobacco, though favorable for corn and pastures. October had 10 rainy days, well distributed throughout the month, and 7.78 inches of rainfall, which delayed fall seedings. Nevertheless, fall harvesting and seedings were completed; all fall and winter plowing was done; tobacco plant beds were prepared and dormant sprays applied.

The wet season made it necessary to cut alfalfa the fourth time. An ample supply of alfalfa and other hay was produced. A good yield of wheat, 20-25 bushels per acre, was harvested from one of the thinner fields of the sandstone tract. This field now has an excellent green cover of red clover, ladino, orchard grass, fescue, bluegrass, and redbud. Another 18-acre field on the sandstone land produced an excellent crop of corn from which two 75-ton silos were filled and about 300 bushels of ear corn was harvested. This field was re-treated with limestone and phosphate and seeded to wheat and grass this fall.

All pastures were mowed several times during the growing season. About 40 acres of permanent pastureland on the Jacob Tract was top-dressed with limestone and about 25 acres of the same field was top-dressed with superphosphate.

Approximately 1,600 bushels of peaches and 1,200 bushels of apples

were harvested. The large crop of peaches and apples throughout the country this year resulted in difficult marketing and lower prices.

Dairy herd.—The dairy herd of purebred Jerseys included at the close of the year 18 cows, 16 heifers, 8 heifer calves, 1 bull calf, and 1 herd bull. All animals reacted negatively to recent tests for tuberculosis and Bang's disease. Grade "A" milk was produced and sold to a local distributor. Average production of the herd was somewhat lower than the high records of the last two years, partly because several good old cows were replaced by heifers which have not produced as well as expected.

U. K. Best Bet Kitten, the best cow in the herd, received the American Jersey Cattle Club "Ton of Gold" Certificate for producing 2,019 pounds of butterfat in four consecutive years. This cow has now produced a total of 125,290 pounds of milk and 5,637 pounds of butterfat. Her average production per 10-month lactation was 10,951 pounds of milk and 487 pounds of butterfat. Her highest 10-month record was made at the age of thirteen years when she produced 12,949 pounds of milk and 598 pounds of butterfat. She is the last of nineteen daughters sired by U. K. Observer Best Bet, the best herd sire ever used here. Two of her daughters are now among the highest producing cows of this herd.

Breeding by artificial insemination was begun here this year, following the recent organization of an artificial breeding association in this section. Only part of the cows are bred artificially, the remainder being bred naturally for the purpose of proving new bulls.

Poultry flocks.—The poultry flocks now include 488 pullets and 36 male birds, divided into three pens of New Hampshires and three of Barred Plymouth Rocks. Twelve hundred baby chicks (600 New Hampshires and 600 Barred Rocks) were brooded this year. During the first 5 weeks all broods were fed the same all-mash starting ration. From the 6th through the 23rd week these chicks were on a growth ration of cracked or shelled yellow corn, whole wheat, a protein mixture, and steamed bonemeal, each fed in separate hoppers. One brood of each breed was fed a protein mixture of 50 pounds of meat scrap and 50 pounds of distillers' dried solubles plus 2 percent salt. The second brood of each breed was fed a protein mixture of 50 pounds of soybean oilmeal and 50 pounds distillers' dried solubles plus 2 percent salt.

As in 1948, all broods made satisfactory growth and there was very little difference in the weight of the chicks fed the different protein mixtures. Averaging results of both breeds, there was less than 0.1 pound difference in the average weight of the cockerels when removed at the end of the 12th week, or in the weight of the pullets at the same time. At 23 weeks of age the pullets fed the meat scrap and distillers' solubles averaged almost 0.2 pound heavier than the other group. Production of the pullets from September 1 to December 1 was 5.5 eggs higher in the New Hampshires and 10.5 eggs higher in the Barred Rocks in favor of the chickens that had received the mixture of meat scrap and distillers' solubles.

Apple varieties and cover-crop tests.—Apple trees, 23 years old, that have been in lespedeza sod the past 20 years averaged 10.5

bushels per tree. On a cultivated plot, with rye and vetch as a winter cover crop and soybeans as a summer crop, trees of the same age averaged 8.6 bushels per acre. On the sod plot the trees appear more vigorous and there has been much less soil erosion. Yields of the four varieties in bushels per tree were Red Delicious, 12.8; Stayman, 10.4; Yellow Transparent, 8.7; and Winesap, 7.3.

Peach varieties.— Among the newer varieties Dixired, a very early yellow clingstone, showed outstanding possibilities as an early peach to come ahead of the old Red Bird. Erly Red Fre again showed outstanding promise as a more desirable white peach to fill in the Red Bird season, the Red Bird being of very low quality and quite subject to brown rot. New varieties, fruiting for the first time, that gave promise were Dixigem, Jerseyland, Fairhaven, Prairie Rose, Nectar, Bray Elberta, Snyder Elberta, and Red Skin. Older varieties that continued to show promise and usefulness were: Marigold, Redhaven, Raritan Rose, Golden Jubilee, Triogem, Fair Beauty, Halehaven, July Elberta, Sunhigh, Goldeneast, Sullivans Early Elberta, Veteran, Summercrest, Golden Gem, Afterglow, and Barbara. Prairie Dawn, Prairie Daybreak, and Prairie Sunrise also indicated promise as new varieties but the young trees had only a small crop this year.

Outstanding clingstones were the white-fleshed July Heath and the yellow-fleshed Ambergem. These two varieties ripen two weeks ahead of Elberta and have given good results over a period of years. Fairhaven, a new variety that overlaps the Golden Jubilee in season, proved to be outstanding in fruit characters and set a heavy crop that needed thinning. In this respect, it seems to perform similarly to the Redhaven and Halehaven, two close relatives that also set heavy crops of fruit that require early and heavy thinning.

Fireglow again failed to set an adequate crop. This variety has splendid fruit characters but has so often failed to set a satisfactory crop that it must be considered unsatisfactory for this location. Sunbeam set another full crop but failed to size its fruit satisfactorily. This variety has produced small fruit for a number of years, and is now being dropped from the tests.

Peach spray tests.— For the second year, where light curculio infestations were concerned, the standard lead arsenate spray program was more satisfactory than a non-arsenical spray program consisting of benzene hexachloride in the first-brood and chlordane in the second-brood. The lead-arsenate plots were also virtually free of leaf roller injury, which amounted to 6 percent in the non-arsenical plots. The fruit from the arsenical plots was earlier in maturity, more highly colored, and had less brown rot.

DDT applied at bloom stage was beneficial in reducing catfacing; also, DDT, when applied 3 weeks before harvest, was beneficial in reducing injury by the oriental fruit moth. However, where preharvest DDT applications were made, the red mite and red spider injury increased greatly.

Liquid lime sulfur, 2 quarts per 100 gallons, applied just before harvest, caused no foliage or fruit injury and reduced brown rot.

Forage yields of grasses.— Grasses tested for herbage production included tall fescue, orchard grass, timothy, and redtop.

The tall fescue varieties, produced considerably more forage from a hay cutting in late May than any of the other grasses. Ranges in yields of dry matter per acre for the four species were as follows: tall fescue 3,692-4,521 pounds; orchard grass 2,202-2,511 pounds; timothy 1,818-2,771 pounds; and redtop 2,962-3,549 pounds. The redtop yields were 3,549 pounds of dry matter per acre for commercial seed (Illinois) and 2,962 pounds for Reton, a Canadian variety. Timothy yields were as follows: Marietta 2,771 pounds, Shelby 2,314 pounds, Milton 2,270 pounds, and Drummond 1,818 pounds. The last two varieties of timothy are of Canadian origin. All orchard grass varieties entered in this test were old Kentucky strains.

Red clover strains.—Seven strains of red clover, replicated six times on small plots, were harvested this year. Though there were great soil variations within the experimental area, the yields of Kenland and Kentucky 215 were not significantly different. However the average yields of these varieties, 4,050 pounds of dry matter per acre from two cuttings, were significantly higher than the 2,915 pounds of dry matter produced by the Midland variety. Wisconsin and Oregon clovers produced 2,130 and 1,605 pounds of dry matter per acre, respectively.

Effect of legumes on crop yields.—Various legumes and timothy have been compared in a long-time test for the purpose of determining their effect on crop yields in the rotation. All rotations are corn the first year, wheat the second, and hay the third. Sweet clover, alfalfa, red clover, and lespedeza have been about equally effective in increasing productivity of the soil as measured by corn and wheat yields. Following timothy, corn yield has averaged 10 bushels per acre less and wheat 5 bushels less than after the above legumes. On plots with cowpea or soybean hay as the third-year crop, corn yields have been 20 bushels lower and wheat yields about 8 bushels less than after the other legumes. These cowpea and soybean plots have not been limed, while the others have been.

Place of fertilizer applications in the rotation.—In a 20-year fertility experiment, phosphate or phosphate and potash were applied to some plots when corn was planted and to others when wheat was seeded in a three-year rotation of corn, wheat, and hay. In some individual comparisons, corn yields have been slightly greater when phosphate and potash fertilizers were applied ahead of the corn crop, but wheat and hay yields in the same rotations were not as good as on plots fertilized ahead of wheat. Averaging the results of four separate comparisons during the first six rounds of the rotation, corn, wheat, and hay yields on the plots fertilized at time of wheat seeding have been higher, as follows:

<i>Treatment*</i>	<i>Bushels per acre</i>		
	<i>Corn</i>	<i>Wheat</i>	<i>Hay</i>
Phosphate, or phosphate and potash, applied at wheat seeding	46.5	21.5	3903
Phosphate, or phosphate and potash, applied when corn was planted	45.0	18.3	3557

* All plots were treated with lime and manure and half of them received nitrogen fertilizer.

Phosphate tests on sandstone soil.—Various phosphates have been compared, since 1930, in a three-year rotation of corn, wheat, and legume-grass hay on sandstone soil. Superphosphate and basic slag were applied at rates to supply equal amounts of phosphoric acid. Fine-ground (300-mesh) and coarse-ground (100-mesh) rock phosphate were applied at rates to supply twice as much phosphoric acid as the superphosphate and basic slag. Potash, nitrate, and manure have been used with all the phosphates.

On unlimed land, the yield of corn, wheat, and hay during the first six rounds of the rotation has been highest on the plot receiving 300-mesh rock phosphate. Yields on the superphosphate plot were only slightly lower on corn and wheat and 620 pounds per acre lower on hay. The basic-slag plot yielded only 2.8 bushels less corn, 1.7 bushels less wheat, and 185 pounds less hay per acre than the 300-mesh rock phosphate plot. On limed plots, the plot receiving 300-mesh rock phosphate yielded 1.2 bushels more corn and 296 pounds more hay per acre than the superphosphate plot. On the plot receiving the 100-mesh rock phosphate, yields have been only slightly lower than on the plot receiving the 300-mesh materials. All these phosphates have produced satisfactorily on this sandstone soil. Other tests show rock phosphate to be somewhat less effective on limestone soil.

Dark tobacco varieties.—Twenty-three different varieties or strains of dark tobacco were grown this year. Seven of these are mosaic-resistant strains, as good in type as the standard varieties. Ky 151 and Ky 153 are mosaic-resistant strains of Brown Leaf; Ky 152 is a mosaic-resistant of Little Crittenden; and Ky 154 is a mosaic-resistant strain of Little Orinoco. Each of these closely resembles the dominant parent variety. Ky 160 and Ky 161 are good one-sucker varieties which are also resistant to mosaic. Seed of several of the above varieties have been distributed to farmers.

Seven new strains, resistant to both mosaic and black root rot disease, were tried this year. They proved to be somewhat inferior to the standard varieties in type. Further improvement in these is being sought in work at the Station at Lexington.

The disease-resistant hybrids, especially Ky 151 and Ky 153, were more susceptible to lice injury than the standard varieties.

Corn hybrids.—Sixteen white and 10 yellow corn hybrids were grown this year, each replicated five times on plots of 30 hills each. Hills were spaced 42 inches apart each way with two plants per hill. The white hybrids averaged 84.6 bushels and the yellow hybrids 77.0 bushels per acre. The white hybrid Dixie 17 produced the highest average yield, 112.4 bushels per acre, 21.6 bushels more than the second highest yielding hybrid, Ky 423B. Dixie 17 averaged two ears per plant or four ears per hill, whereas Ky 423B had an average of slightly less than three ears per hill. Many of the ears of Dixie 17, however, were small and stalks were very tall with ears 68 inches from the ground. Following Dixie 17 and Ky 423B the next five hybrids, in order of highest yield, were Ky 7114, Ky 418, Woods V125, Ky 423A, and Ky 72B. Yields of these ranged from 90.8 to 85.9 bushels per acre. All of the highest ten in yield were white hybrids.

Dixie 44 was the highest yielding yellow hybrid, ranking eleventh in the whole test and averaging 82.9 bushels per acre. Ky 9006 with 80.8 bushels per acre and Ky 102 with 80.6 bushels per acre were next in rank. Yields of other yellow hybrids ranged from 78.1 to 70.6 bushels per acre.

Wheat varieties.—Yields of nine out of ten varieties of wheat tested this year ranged from 23.1 to 21.2 bushels per acre. The tenth variety, Redheart, which made the highest yield in 1948, made a low yield this year because of winter injury. Listed in order of highest to lowest yield, the varieties were Currell's Prolific—R47, N. S. 6, TN1016, Clarkan, Vigo, Thorne, Trumbull, Butler, Goens, and Redheart.

ROBINSON SUBSTATION

General farming.—Weather conditions were not as favorable as usual and crops as a whole were not as good as expected. During June and July a period of five weeks without rainfall caused a shortage in the corn crop. From 18 acres there was gathered 1100 bushels of corn, an average of 61 bushels per acre. Hay was saved from 6 acres of alfalfa. From 3 acres of old-stand alfalfa four cuttings were made, and from 3 acres of new seeding one cutting of oats and one cutting of alfalfa were made. From all cuttings 12 to 15 tons of hay was saved.

Permanent pastures at the Substation now amount to approximately 50 acres—20 acres on bottomland and 30 acres on the hillsides. Most of the pastures are seeded to Ky 31 fescue. The bottomland pasture furnished grazing at the rate of one unit to the acre.

Livestock and poultry.—The project on breeding up dairy cattle through the use of purebred Brown Swiss sires on scrub and grade Jersey cows is now in its seventh year. Much of the off-color has been bred out, and most of the animals now resemble Brown Swiss. The first-cross offspring of Brown Swiss with Jersey or scrub are making the best producers. When calculated on a mature-equivalent 305-day two-time milking basis the records for the four scrub cows averaged 5,282 lb milk and 204 lb fat; for six one-half blood Swiss daughters, 8,231 lb milk and 341 lb fat; and for the one three-fourths Swiss granddaughter, 8,040 lb milk and 327 lb fat. The herd now consists of 32 animals: 7 purebred Brown Swiss (1 bull, 1 bull calf, 2 cows, 3 heifers), 1 grade Jersey cow, and 10 cows and 14 heifers ranging from one-half to seven-eighths Brown Swiss. Two cows and 7 veal calves were sold from the herd during the year.

Twelve hundred baby chicks and 350 poults were hatched at the Experiment Station and shipped to the Substation. The turkey eggs for hatching were produced here and the hen eggs were produced here and at the Western Substation. After culling, 400 pullets and 30 turkeys were retained as breeders.

Fruits.—New plots of raspberries, blackberries, and strawberries were set. A 2-year-old planting of grapes made good growth. Because of late spring freezes and extreme dry weather during the past summer, all fruit crops were practically a failure.

NEW PROJECTS — 1949

Method for accelerating the rate of ripening in cheddar cheese.

Animal protein concentrates in breeder diets.

The effect of protein supplement on efficiency and rate of gains by hogs self-fed shelled corn on alfalfa and ladino clover pastures.

Reclamation of strip-mined coal lands in Kentucky.

Economic appraisal of farm woodland in the Eastern Pennyroyal Area of Kentucky with particular reference to comparative values and yields contingent on site and stand quality.

The availability, the function and metabolism of certain minor chemical elements in soils and plants.

Pasture research in the Hill, Outer, and Central bluegrass regions of Kentucky.

Pasture irrigation in Central Bluegrass region of Kentucky.

Pasture irrigation in Western Kentucky.

Demand interrelationships between burley and selected other types of tobacco.

Adapted varieties of red clover, alfalfa, white clover, crimson clover, and birdsfoot trefoil.

Using barn manure on bluegrass pasture.

Adapted varieties of Kentucky bluegrass, orchard grass, tall fescue, smooth brome grass, and timothy.

Seed yields in Kentucky bluegrass, orchard grass, and Ky 31 fescue.

The effect of timing and balancing high nutritional levels on the vigor and quality of tomatoes.

A study of the factors affecting production plans of individual farmers and the allocation of capital and labor between farm family consumption and use in farm production in South Central Kentucky.

Mineral nutrient supply and the metabolism of nitrogen in alfalfa.

The spread of recommended farm practices in Kentucky.

Control of tobacco hornworms.

Control of the tobacco flea beetle, *Epitrix hertipennis* Melch.

Biology and control of cutworms that injure burley and dark tobacco.

PUBLICATIONS

BULLETINS

528. Participation in organized activities in selected Kentucky localities. Harold F. Kaufman. February 1949.
529. Effect of late applications of nitrogen and potassium on potato yields. E. M. Emmert. March 1949.
530. Rural churches in Kentucky, 1947. Harold F. Kaufman. April 1949.
531. Methods and principles of farm development. Ernest J. Nesius. May 1949.
532. Rural population changes in 5 Kentucky mountain districts, 1943 to 1946. James S. Brown and Howard W. Beers. June 1949.
533. Winter survival of sheep parasites on a pasture in Kentucky. A. C. Todd, G. W. Kelley, and M. F. Hansen. June 1949.
534. Farmers' cooperative fire insurance companies in Kentucky. H. B. Price and H. B. Clark. June 1949.
535. Seed production of Kentucky bluegrass as influenced by insects, fertilizers, and sod management. J. T. Spencer, H. H. Jewett, and E. N. Fergus. June 1949.

536. Worm parasites in Thoroughbred mares. A. C. Todd, F. E. Hull, G. W. Kelley, Z. N. Wyant, M. F. Hansen. June 1949.
537. Larvae of melolonthinae. P. O. Richter. June 1949.
538. Rural family health in a selected county in Kentucky. Marie Mason. June 1949.
539. Efficiency of natural breeding in dairy cattle. Durward Olds, H. B. Morrison, D. M. Seath. September 1949.
540. Growers' losses on burley tobacco sold in high order. Dana G. Card. November 1949.
541. Worm parasites in Thoroughbred sucklings and weanlings. A. C. Todd, G. W. Kelley, Z. N. Wyant, M. F. Hansen, F. E. Hull. November 1949.
542. May beetles and their control in the Inner Bluegrass region of Kentucky. P. O. Richter. December 1949.
543. The ballerup group of paracolon bacteria. D. W. Bruner, P. R. Edwards, Alice S. Hopson. December 1949.
544. Farming in the bluegrass, costs and returns 1930-48. Erling Hole and John H. Bondurant. December 1949.

The following bulletins were reprinted:

493. Forest fires, basal wounds, and resulting damage to timber in an eastern Kentucky area. R. O. Gustafson.
507. Farms and forests of eastern Kentucky in relation to population and income. William A. Duerr, John H. Bondurant, W. D. Nicholls, Howard W. Beers, R. O. Gustafson, and John B. Roberts.

REGULATORY BULLETINS

70. Quarterly report on official feed samples analyzed. July, August, and September, 1948. Bruce Poundstone. February 1949.
71. Commercial feeds in Kentucky, 1948, including report on official feed samples analyzed October, November, and December, 1948. Bruce Poundstone. February 1949.
72. Quarterly report on official feed samples analyzed. January, February, and March, 1949. Bruce Poundstone. February 1949.
73. Commercial fertilizers in Kentucky, 1948, including a report on official fertilizer samples analyzed, July-December, 1948. Bruce Poundstone. July 1949.
74. Quarterly report on official feed samples analyzed. April, May, and June, 1949. Bruce Poundstone. August 1949.
75. Some items of interest to Kentucky nurserymen, for the year ended June 30, 1949. W. A. Price and Howard G. Tilson. September 1949.
76. Analyses of official fertilizer samples by the Feed and Fertilizer Department Kentucky Agricultural Experiment Station. Semi-annual report January-June, 1949. Bruce Poundstone. October 1949.
77. Quarterly report on official feed samples analyzed. July, August, and September, 1949. Bruce Poundstone. October 1949.
78. Seed inspection in Kentucky, 1948-49, by the Entomology and Botany Department Kentucky Agricultural Experiment Station. Annual report for the year May 1, 1948 to April 30, 1949. W. A. Price. October 1949.

ANNUAL REPORT

Sixty-first annual report of the Experiment Station (for 1948). Thomas P. Cooper, Director. June 1949.

EXPERIMENT STATION CIRCULARS

62. Botulism in domestic animals. W. W. Dimock and Zae N. Wyant. June 1949.
63. Barren broodmares. W. W. Dimock and D. W. Bruner. October 1949.
64. A key to Kentucky soils. W. S. Ligon and P. E. Karraker. November 1949.
65. Can you own your farm? North Central Regional Publication No. 14 by Francis A. Kutish and the North Central Regional Land Tenure Research Committee subcommittee on farm ownership. November 1949.
66. Character and extent of land stripped for coal in Kentucky. Robert W. Merz. December 1949.

The following experiment station circulars were reprinted:

54. Serological identification of *Salmonella* cultures. P. R. Edwards and D. W. Bruner. December 1949.
56. Diseases of sheep. F. E. Hull and E. R. Doll. March 1949.

SCIENTIFIC PAPERS

In Agronomy

- Breeding low-nicotine tobacco. W. D. Valleau. Jour. of Agr. 78: 7, April 1, 1949.
- The genetics of mosaic resistance in *Nicotiana glutinosa*. W. D. Valleau. Jour. of Agr. Res. 78: 3, 4, February 1 and 15, 1949.
- Report on the determination of iodine in plants and soils. Forrest G. Houston and L. K. Wood. Presented at sixty-third annual meeting of the Assoc. of Off. Agr. Chem. October 1949.
- Soil iodine. Forrest G. Houston. Presented at annual meeting of Ky. Acad. Sci., October 1949.
- Synonymy in some common species of cercospora. E. M. Johnson and W. D. Valleau. Phytopathology 39:10, October 1949.

In Animal Industry

- The comparative rates of growth and calcification of the femur, tibia, and metatarsus bones of male and female New Hampshire chickens having crooked keels. G. Davis Buckner, W. M. Insko, Jr., Amanda Harms Henry, and Elizabeth Faull Wachs. Presented at annual meeting of Ky. Acad. of Sci., October 1949.
- The comparative rates of growth and calcification of the femur, tibia, and metatarsus bones of the male and female New Hampshire chickens having straight keels. G. Davis Buckner, W. M. Insko, Jr., Amanda Harms Henry, and Elizabeth Faull Wachs. Presented at annual meeting of Poultry Sci. Assoc., August 1949.
- Corn gluten meal versus soybean meal in animal protein factor studies in laying hens. T. G. Culton, W. M. Insko, Jr., and W. T. Chaffin, Jr. Poultry Sci. 28. Presented at annual meeting of Poultry Sci. Assoc., August 1949.
- The digestibility and metabolizability by lambs of a standard ration of alfalfa and corn and one containing cottonseed hulls. R. M. Forbes and W. P. Garrigus. Jour. of Agr. Res. 78: 11, June 1949.
- Fiber in chick starting rations. W. M. Insko, Jr., and T. G. Culton. Poultry Sci. 28. Presented at annual meeting of Poultry Sci. Assoc., August 1949.
- Further observations on determination of nutrient intake by grazing animals. R. M. Forbes and W. P. Garrigus. Jour. of Anim. Sci. 8: 4, November 1949.
- The growth and calcification of the humeri of male and female New Hampshire chickens having crooked keels. G. Davis Buckner, W. M. Insko, Jr., Amanda Harms Henry, and Elizabeth Faull Wachs. Poultry Sci. 28: 5, September 1949.
- Grain and hay saving values of distillers feeds. W. P. Garrigus. Proc. Fourth Conf. on Feeds and of the Grain Distill. March 1949.
- Rate of growth and calcification of the sternum of male and female New Hampshire chickens having crooked keels. G. Davis Buckner, W. M. Insko, Jr., Amanda H. Henry, and Elizabeth Faull Wachs. Poultry Sci. 28: 2, March 1949.
- Some difficulties involved in the use of fecal nitrogen as a measure of dry matter intake of grazing animals. R. M. Forbes. Jour. of Anim. Sci. 8: 1, November 1949.

In Animal Pathology

- Aggregate worm infections and growth of broilers. A. C. Todd, W. M. Insko, Jr., G. W. Kelley, and M. F. Hansen. Amer. Micros. Soc. Trans. 68: 256-60, July 1949.
- Blood factors and baby pig anemia. D. W. Bruner, R. G. Brown, F. E. Hull, and Alice S. Kinkaid. Amer. Vet. Med. Assoc. Jour. 115: 94-6, August 1949.
- A check list of parasites of horses in Kentucky. L. S. Olsen, A. C. Todd, and M. F. Hansen. Jour. Parasitol. 35 (6 section 2): 40-41, December 1949.
- Continuous phenothiazine therapy for horses. I: Effect on the worm parasites. A. C. Todd, M. F. Hansen, G. W. Kelley, and Z. N. Wyant. Vet. Med. 44: 411-4, October 1949.
- Continuous phenothiazine therapy for horses. II: Hematological studies with a note on post-mortem findings. M. F. Hansen, A. C. Todd, and G. W. Kelley. Vet. Med. 44: 461-4, November 1949.
- DDT and infective tapeworm larvae. A. C. Todd and M. F. Hansen. Poultry Sci. 28: 626-7, June 1949.
- Delayed conception and sterility in broodmares. W. W. Dimock. Auburn Vet. 5: 69-70, February 1949.
- Diet of hens and development of *Ascaridis galli* in their chicks. A. C. Todd and M. F. Hansen. Jour. Parasitol. 35 (6 section 2): 36, December 1949.

- Dosage of caronamide required for inhibition of renal tubular excretion of penicillin in horses. E. R. Doll, M. E. Wallace, and Anna Newton. *Amer. Vet. Res. Jour.* 10: 154-7, April 1949.
- Further studies on the Bethesda group of paracolon bacteria. Alice B. Moran and D. W. Bruner. *Jour. Bact.* 58: 695-700, November 1949.
- Horse meat infusion agar medium. D. W. Bruner. *North Amer. Vet.* 30: 243, April 1949.
- Induced hyperthyroidism and growth of parasitized chicks. A. C. Todd, T. G. Culton, G. W. Kelley, and M. F. Hansen. *Poultry Sci.* 28: 549-51, July 1949.
- Jaundiced-foal producing mares and jaundiced foals. D. W. Bruner, F. E. Hull, and E. R. Doll. *The Blood Horse* 57: 83, July 1949.
- Mechanical pneumonia in a foal. R. G. Brown. *Auburn Vet.* 5: 71, February 1949.
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FINANCIAL STATEMENT

EXPENDITURES OF FEDERAL AND OFFSET FUNDS

BY PROJECTS, FOR THE FISCAL YEAR

ENDED JUNE 30, 1949

Receipts and expenditures under Hatch, Adams, Purnell, Bankhead-Jones Acts and under Sections 9(b)1 and 9(b)2 of the Research and Marketing Act

RECEIPTS			
Federal Funds:	Balance From 1948	Receipts From U.S. Treasury	Total
Hatch	None	\$ 15,000.00	\$ 15,000.00
Adams	None	15,000.00	15,000.00
Purnell	None	60,000.00	60,000.00
Bankhead-Jones	None	95,122.25	95,122.25
Research and Marketing Sections 9(b)1 and 9(b)2	\$19,134.89	75,013.23	94,148.12
TOTAL	\$19,134.89	\$260,135.48	\$279,270.37

EXPENDITURES					
Purpose	Hatch	Adams	Purnell	Bankhead- Jones	Research and Marketing 9(b)1-9(b)2
Personal Services:					
Administration	\$ 3,500.00				
For all other purposes	10,979.27	15,000.00	\$ 48,248.70	\$ 78,245.22	\$ 56,605.03
Travel			3,265.69	2,595.61	5,634.02
Transportation of Things			38.34	76.97	47.28
Communication Service			9.86	7.65	96.19
Printing and Binding:					
Printing Publications	463.34		5,793.55	2,099.10	818.98
Other Contractual Services:					
Repairs and alterations to equipment, and other contrac- tual services not other wise- classified			61.70	150.08	226.68
Supplies and Materials:					
Used in construction, repair, or alteration of buildings	57.30		1,394.05	9,297.31	10,331.71
Equipment			1,188.11	2,650.11	5,972.52
TOTAL EXPENDITURES	\$15,000.00	\$15,000.00	\$60,000.00	\$95,122.25	\$79,732.41
Unexpended Balances, June 30, 1949	None	None	None	None	\$14,415.71
TOTAL APPROVED EXPENDITURES, NON-FEDERAL FUNDS	\$174,855.33				

We the undersigned, certify that the receipts and expenditures shown in this report from Federal funds and as offset to Bankhead-Jones and Sections 9(b)1 and 9(b)2, of Title I, Research and Marketing funds are correct; that the expenditures were solely for the purposes set forth in the acts of Congress approved March 2, 1887 (Hatch), March 16, 1906 (Adams), February 24, 1925 (Purnell), May 16, 1928 (Hawaii), March 4, 1931 (Puerto Rico), June 29, 1935 (Bankhead-Jones, Title I), March 4, 1940 (Employer Contributions to Retirement), and August 14, 1946 (Research and Marketing, Sections 9(b)1 and 9(b)2, Title I); that the expenditures are in accordance with the terms of said acts so far as applicable to this station; and that properly approved vouchers are on file for all expenditures.

Signed:

THOMAS COOPER
Director of Experiment Station

FRANK D. PETERSON
*Comptroller (Legal Custodian of
Federal funds)*

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